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REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Monroe Harbor, Michigan.
2. Toledo Harbor, Ohio.
3. Port Clinton Harbor, Ohio.
4. Sandusky Harbor, Ohio.
5. Sandusky River, Ohio.
6. Huron Harbor, Ohio.
7. Vermilion Harbor, Ohio.
8. Black River Harbor, Ohio.
9. Cleveland Harbor, Ohio.
10. Fairport Harbor, Ohio.
11. Ashtabula Harbor, Ohio.
12. Conneaut Harbor, Ohio.

SURVEY.

13. Ashtabula Harbor, Ohio.

HARBOR LINES.

14. Cleveland Harbor, Ohio.
15. Fairport Harbor, Ohio.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, July 9, 1895.

GENERAL: I have the honor to forward herewith annual reports for works in my charge for fiscal year ending June 30, 1895. In carrying on the works of river and harbor improvement I have been very faithfully and ably assisted by Mr. William T. Blunt and Mr. F. S. Burrowes, United States assistant engineers.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

M M 1.

IMPROVEMENT OF MONROE HARBOR, MICHIGAN.

In 1834 the Raisin River emptied into Lake Erie at the southerly end of a low, marshy peninsula lying between the channel and the lake. The water at the mouth was very shallow, being over a bar on which the deepest soundings were only 5 feet.

A plan was proposed to improve the channel by cutting a canal across the neck of the peninsula and extending piers from its mouth to a depth of 10 feet in the lake. The canal thus planned was 4,000 feet long, 100 feet wide, and 10 feet deep, with sides protected by oak sheet piling, secured above water to waling pieces bolted to heavy oak piles.

The amount expended in construction and maintenance of the channel from 1835 to 1882, inclusive, was $213,515.27.

The original construction was completed many years ago, and a lighthouse and keeper's dwelling were erected on the outer end of the north pier. The piers diverge so that the entrance is about 200 feet wide. In the channel of the river to the wharves at Monroe, a distance of 2½ miles from the lake, the depth is 9 feet or more, and about the same depth is maintained over the bar.

In 1886 a project was adopted to repair the piers and canal revetment and to dredge the channel if necessary. The original estimate of cost was $20,000. The work, being old, however, deteriorated faster than the repairs were made under very small appropriations, so that in 1891, after $12,000 had been expended, covering five years, it became necessary to increase the estimate for completion to $26,000, which was equivalent to making the original estimate $38,000.

The following appropriations have been made for the repairs:

August 5, 1886	$2,000
August 11, 1888	5,000
September 19, 1890	5,000
July 13, 1892	10,000
August 17, 1894	5,000
Total	27,000
Expended and incurred to June 30, 1894	21,915

Various repairs were made from time to time, and in 1893 the superstructure of north pier, a total length of 1,122 linear feet, was entirely rebuilt to a height of 6 feet above water. The depths of water remain practically the same as they were a year ago, the channel depth at that time over the bar and in the river channel being 9 feet or more.

The last appropriation of $5,000 is being expended in renewing superstructure of south pier. The timber and iron have been purchased by contract after advertising, the contracts being made with the lowest bidders.

All the timber and iron have been delivered. The work of tearing out old superstructure was begun May 8, 1895.

The outer end of the pier for a short distance is 18 feet wide and is in fair condition, having been repaired a few years ago. From the inner end of the part of 18 feet width the crib is 12 wide, except a part 170 feet long, which is but 7½ feet wide. A length of 520 feet of old superstructure has been removed; 270 linear feet has been rebuilt, 60 feet more has been completed except deck joists, and 30 feet has been leveled up and one course of timber has been put on.

Amount expended and incurred in last fiscal year $1,113.18

The balance now available will be expended in repairs of the south pier.

The revetment of the canal is in very bad condition, and as it is necessary for preservation of the channel, it should be repaired. When the canal was first constructed it was cut through lands owned by the United States. The lands were subsequently ceded to the State of Michigan. It has been held by the Attorney-General of the United

States that a reservation 50 feet wide on each side of the canal is still vested in the United States.

The commerce of the place is very small and is not increasing, so that no deepening of the channel is likely to be required. Excursion steamers run to the piers from Toledo during the summer season.

The harbor of Monroe is in the collection district of Detroit, Mich. There is a light-house on the outer end of the west pier.

Money statement.

July 1, 1894, balance unexpended	$100.00
Amount appropriated by act of August 17, 1894	5,000.00
	5,100.00
June 30, 1895, amount expended during fiscal year	485.06
July 1, 1895, balance unexpended	4,614.94
July 1, 1895, outstanding liabilities	628.12
July 1, 1895, balance available	3,986.82
Amount (estimated) required for completion of existing project	11,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	11,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals for furnishing and delivering timber and iron for repair of pier at entrance to Monroe Harbor, Michigan, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Tuesday, February 12, 1895, at 2 o'clock p. m., standard time, in accordance with advertisement dated January 18, 1895.

[Net amount available for the purchases, $3,000.]

No.	Name and address of bidder.	White pine timber, per M feet B. M.	Driftbolts, per cwt.	Spikes, per cwt.	Total.
1	Russel Wheel and Foundry Co., Detroit, Mich	.....	$2.25	$2.45	$154.88
2	William Howard Prescott, Cleveland, Ohio	$24.70	.....	.....	3,104.10
3	C. E. Mitchell & Co., Ludington, Mich.*	21.85	.....	.....	2,745.93
4	Geo. F. Finzel, Monroe, Mich	.....	2.00	2.00	134.20
5	The Upson Nut Co., Cleveland, Ohio†	.....	1.55	1.95	111.81
6	Walter P. Sterling, Monroe, Mich	25.25	2.25	2.50	3,329.07
7	Wallace M. Pattison, Cleveland, Ohio	.....	1.80	2.20	128.58

* Lowest for timber. Incomplete. † Lowest for iron.

Recommended that the contract for timber be awarded to Messrs. C. E. Mitchell & Co., of Ludington, Mich., and for iron to the Upson Nut Company, of Cleveland, Ohio, at the rates named in their proposals, these bids being the lowest, and considered reasonably low.

COMMERCIAL STATISTICS.

The following statistics for the year 1894, relative to the commerce of the harbor at Monroe, Mich., were compiled from information furnished by the collector of customs and others:

Receipts:	Tons.
Sand	384
Cedar poles	29,650
Total	30,034

	Tons.
Shipments:	
Fish	200
Total freight tonnage:	
1894	30,234
1893	Not given.

Vessels.	Number.	Tonnage.
Entering	213	5,145
Departing	219	5,157

Total registered tonnage:	
1894	10,302
1893	Not given.

Draft of largest vessels using harbor, 11 feet. Largest vessels do not load to full depth. New lines of transportation were established as follows, viz: The Monroe and Toledo Excursion Company and the Monroe Pier Hotel Company Line.

M M 2.

IMPROVEMENT OF TOLEDO HARBOR, OHIO.

The original project for improving this harbor was adopted in 1866, pursuant to the requirement of river and harbor act approved June 23, 1866, which appropriated $20,000 for the improvement. The project provided for improving the old channel through Maumee Bay by dredging to a depth of 12 feet and width of 200 feet. The plan was amended from time to time as necessities increased, until the old channel had been dredged to a depth of 16 feet. In 1892 it had filled somewhat, so that the mid-channel depth was about 15.5 feet.

The total amount appropriated and expended on the old channel is $724,332.61.

In 1887 a project was approved by the Secretary of War for a straight channel through Maumee Bay, in compliance with previous acts of Congress. The channel was so located as to utilize the old channel as far as possible, and was to be 200 feet wide at the bottom and 17 feet deep.

Upon the basis of protecting the channel by revetments or piers through at least a part of its length, the cost of the project was estimated to be $1,875,000.

The following appropriations have been made since the adoption of the project for a straight channel:

July 5, 1884	$25,000.00
Deduct amount reappropriated for old channel (see note)	9,632.61
	15,367.39
August 5, 1886	112,500.00
August 11, 1888	150,000.00
September 19, 1890	200,000.00
July 13, 1892	200,000.00
August 17, 1894	70,000.00
Total	747,867.39

NOTE.—By act of August 5, 1886, the balance then available of amount appropriated July 5, 1884, for straight channel was made available for clearing the old channel.

Expenditures incurred on straight channel to June 30, 1894	$583,763.26
Incurred in last fiscal year	97,205.74
July 1, 1895, balance for carrying on the work	66,898.39

June 30, 1894, the entire channel had been dredged as originally planned and much of it had been redredged to maintain or increase the depths.

At the beginning of the fiscal year a contract was outstanding with Messrs. George H. Breymann & Bros., of Toledo, Ohio, for dredging in the straight channel; work under the contract was continued until November 24, 1894, when it was completed and the contract closed.

Under this contract amounts were dredged as follows:

Outer section, 264,281 cubic yards, at 16 cents	$42,284.96
Turn-out section, 63,787 cubic yards, at 14 cents	8,930.18
Inner section, 395,045 cubic yards, at 12 cents	47,405.40
Removing logs 1½ hours	28.39
Total, 702,319 cubic yards and logging	98,648.93
After payments were made for work under above contract the amount of funds, including appropriation of August 17, 1894, available for further operations was, approximately	89,000.00

The project for expenditure of this amount was as follows:

First. To maintain and operate the United States dredge plant pertaining to the improvement	40,000.00
This dredge to complete the channels, extending the improvement up the river, and after its completion to do such dredging in the straight channel as may be required.	
Second. Dredging by contract after advertising in the usual manner	40,000.00
The work by contract to be, first, to clear the inner section of straight channel, and then to widen outer section as far as possible.	
Third. For contingencies and emergencies of all kinds	9,000.00

In accordance with this plan proposals for dredging were invited by public advertisement, dated February 1, 1895.

Bids were opened March 1, 1895, and the contract for the work was awarded to Mr. James Rooney, of Toledo, Ohio, who was the lowest bidder, at 11 cents per cublic yard for dredging inner section and 13 cents per cubic yard for outer section.

Work was begun with a single dredge May 6, and another dredge was added on May 15, 1895. Both dredges were working at the close of the fiscal year. This dredging will be continued until the amount allotted has been expended.

Amount dredged under this contract previous to July 1, 1895, 80,608 cubic yards, all of which was in inner section.

The dredging under contracts in the last year has been in removing shoal parts of channels previously dredged to the grade of 17 feet. In the dredging by Breymann & Bros. four cuts, each about 40 feet, were made; one cut was made on each side of the channel to a depth of 21 feet, and a cut bordering each of these to a depth of 19 feet; the middle, about 40 feet wide, was not dredged.

By this method the best results are obtained. The dredges are less in the way of passing vessels than they would otherwise be. The cuts are deeper, and therefore the material is more cheaply removed, and by cutting to a deeper grade the banks have a place to fill before the material can encroach upon the proper depth of channel. The continual passing of steamers through the channel keeps the bottom stirred up and maintains the depth in the middle, but tends to increase the deposit near the sides of the channel.

In the later contract with Mr. Rooney the outer cuts are made to leave a depth of 19 feet and the middle cuts a depth of 18 feet; dredging is over the entire area of the channel.

For a further discussion of the dredging and conditions which fill the channel, I refer to the report of Mr. Willian T. Blunt, assistant engineer, which is appended hereto.

Further observation regarding discussion of fill in the channel, as shown by comparative sections shown on drawings accompanying annual reports for 1893 and 1894, leads to the conclusion that a comparison of the sections is useful only in a general way. In the open bay it is not practicable to make the sections in exactly the same places in the successive years, and soundings could not in any event be made in precisely the same spots. It is also true that the soundings themselves are only approximately correct. They are taken from a boat in motion, and often when there is a sufficient ripple upon the water to make the measurement depend to some extent upon the judgment of the man at the sounding pole or line, and no time is afforded to hold the pole or line exactly vertical when the sounding is taken. An opportunity for personal error is thus introduced, which, added to possible variations from other causes, greatly limits the value of the comparisons.

At the end of the last fiscal year the dredge plant belonging to the United States was engaged in cutting a channel 400 feet wide and about 3,500 feet long over what is known as "The Crossing," midway between the railroad bridges. Work was continued until November 21, 1894, when the dredge was laid up for the winter and to make necessary repairs.

The amount of material removed from the shoal was 104,942 cubic yards, and but a small amount remains to be dredged to complete the work.

The river and harbor act of August 17, 1894, contained the following: "Improving harbor at Toledo, straight channel, through Maumee Bay, Ohio: Continuing improvement, $74,000, a part of which may be used, in the discretion of the Secretary of War, in removing shoal in the old channel and in extending the improvement up the Maumee River."

The old channel covers a length of several miles, and all vessels of heavy draft now take the straight channel. To dredge shoal parts of the old channel would involve a very large amount and would do very little, if any, good. The expenditure of any part of the appropriation for that purpose has therefore not been recommended.

In the summer of 1894 a survey was made of the part of the river above the bridge at Cherry street as far as the bridge of the Lake Shore and Michigan Southern Railway Company. This part of the river contained a shoal nearly 4,000 feet long, where the least depth in mid-channel was but 13 feet, and in a few places there was less than 12 feet depth of water.

A plan was submitted to dredge a channel 400 feet wide and 18 feet deep over the shoal. This project was approved by the Secretary of War. Dredging upon this shoal was commenced April 29, 1895, by the U. S. dredge *Maumee* and was in progress at the end of the fiscal year. June 30, 1895, about one-fourth of the area of the shoal had been dredged; the amount of material removed was 44,426 cubic yards.

A map of Maumee River below the bridge of the Lake Shore and Michigan Southern Railway, and part of Maumee Bay, is forwarded to accompany and explain this report.

With the class of dredges employed upon the lakes it has been the invariable experience that in the first year much time has been lost and expense incurred by the necessity of frequent and often expensive repairs. In this respect the dredge plant built and purchased by the United States has been no exception. The entire cost of repairs to dredge, dump scows, and tug during the year has been $6,558.68. The plant is, however, in much better condition than it was one year ago.

The shoals dug by the U. S. dredge have been far less favorable for good results than the places dredged by contract. The shoal at "The

Crossing" is 5 miles farther from dumping grounds than the contractor's work in 1894 and is 6 miles farther from the grounds than the contractor's work in 1895. The U. S. dredge at no time worked to exceed eight hours in a calendar day, and the time was usually less than six hours because of delay waiting for scows. There were only three scows previous to August 14, 1894, when a new one was purchased for $3,600 and added to the plant. Two more scows are needed and will be purchased as soon as they can be built.

Under these difficulties the cost of dredging with the plant belonging to the work, including repairs and every expense except original cost of plant, was 12.36 cents per cubic yard. It is not probable that the work could have been done by contract at equally favorable rates.

The necessity for a channel of not less than 300 feet wide in the bay is very great and has been repeatedly urged by the vessel owners and shippers. The depth of water, being of first importance, has been maintained in preference to obtaining greater width where the funds have been insufficient for both. As soon as may be practicable, the outer part of channel will be widened.

It is, however, the inner part of channel which most needs the additional width, for the reason that all the traffic of the bay passes through that part, while much of it is diverted to other points and does not pass entirely out to the lake.

While the channel is nominally 200 feet wide, with full depth on the bottom, it is actually much less, for nearly all the fill is on the sides near the banks. The channel is 8 miles long. It is not easy for wide steamers to pass each other, and a very slight variation from the exact line of range lights at night will throw a vessel on the bank.

Two beacons have been built and lighted under direction of the Light-House Board to mark the part of straight channel from mouth of the river to the "turn-out," and modifications of the lights at the "turn-out" have been made so that the entire channel can be used, and is used, at night. Congress has made an appropriation of $20,000 for constructing new light-houses in the middle of the straight channel at the "turn-out." When the new lights are completed it is not probable that either of the old channels will be used to any considerable extent.

From statistics of the year 1894 the commerce of Toledo would seem to have grown since the preceding year; this is, however, probably not correct as the increased amount of commerce shown is rather due to the greater care which has been taken to obtain the information complete.

Toledo is in the collection district of Miami. There is a fixed white light of the fourth order on Turtle Island, and three sets of range lights for parts of the channel.

Money statement.

July 1, 1894, balance unexpended		$96,485.10
Amount appropriated by act of August 17, 1894		70,000.00
		166,485.10
June 30, 1895, amount expended during fiscal year		89,498.12
July 1, 1895, balance unexpended		76,986.98
July 1, 1895, outstanding liabilities	$10,088.59	
July 1, 1895, amount covered by uncompleted contracts	32,005.14	
		42,093.73
July 1, 1895, balance available		34,893.25
Amount (estimated) required for completion of existing project		1,130,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		300,000.00

Submitted in compliance with requirements of section 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. WILLIAM T. BLUNT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, June 30, 1895.

SIR: I have the honor to submit the following notes upon work in Toledo Harbor:

All depths mentioned are given at mean level of Lake Erie, 1860 to 1875, that being the datum plane of lake survey charts. The water this season is somewhat more than a foot below this mean level.

STRAIGHT CHANNEL.

Contract.—George H. Breyman & Bros.—At the beginning of the fiscal year dredge No. 2 had finished work between the cribs and the lake, and had begun work inward from the cribs. When funds were exhausted at the end of last season the channel had been dredged for about 16,800 feet, or to within 6,800 feet of the mouth of the river. As stated in my report of June 30, 1894, the cuts were here made as follows:

Extreme outside cut on each side, 40 feet wide, to 21 feet, cut next inside, 40 feet wide to 19 feet, leaving depths of 20 and 18 feet, respectively, and 40 feet width along middle of channel not dredged, but having a depth of 17 feet.

Material was dumped in the open lake, north-northwest of Turtle Island, in about 13 to 14 feet of water, entirely away from the path of vessels.

Contract.—James Rooney.—Work under this contract was begun May 6, 1895, by one dredge at the point where former contract was finished. A second dredge was soon put at work, and each completes a section of 800 feet length for full width before moving to another. It is necessary with these small dredges to dredge the entire width of channel by eight cuts of 25 feet each. The extreme outside cuts are taken to 21 feet, leaving 20 feet depth, and the rest to 19 feet, leaving 18 feet depth. At the close of the fiscal year about 1,600 feet length had been completed and some work done on the next two sections. Material is deposited as under the Breyman contract.

Condition of channel.—Soundings taken in May and June, 1895, show the following conditions over the portions dredged under the Breyman contract. Average depths are shown on intervals of 10 feet width for full length named.

Ten-foot intervals	Outside of cribs—11,600 feet.			Inside of cribs—13,600 feet.		
	Average depth 1895.	Average fill since dredged in 1893.	Cubic yards.	Average depth 1895.	Average fill since dredged in 1894.	Cubic yards.
Ten-foot interval from north bank:	*Feet.*	*Feet.*		*Feet.*	*Feet.*	
First	16.1	1.9	8,163	18.7	1.3	6,548
Second	16.8	1.2	5,155	19.3	.7	3,526
Third	17	1	4,296	19.5	.5	2,518
Fourth	17.2	.8	3,437	19.7	.3	1,511
Fifth	17.5	.5	2.148	19.1	.....	.....
Sixth	17.8	.2	859	18.2	.....	.....
Seventh	17.9	.1	430	18	.....	.....
Eighth	18.1	.....	.....	18.1	.....	.....
Ninth	18.1	.....	.....	17.5	.....	.....
Tenth (mid-channel)	18.1	.....	.....	17.3	.....	.....
Eleventh (mid-channel)	18.3	.....	.....	17.5	.....	.....
Twelfth	18.3	.....	.....	17.9	.....	.....
Thirteenth	18	.....	.....	18.2	.....	.....
Fourteenth	17.7	.3	1,290	18.1	.....	.....
Fifteenth	17.5	.5	2,148	18.4	.....	.....
Sixteenth	17.2	.8	3,437	19.3	.....	.....
Seventeenth	17	1	4,296	19.5	.5	2,518
Eighteenth	16.8	1.2	5,155	19.4	.6	3,022
Nineteenth	16.8	1.2	5,155	19.1	.9	4,533
Twentieth (next to south bank)	16	2	8,592	17.8	2.2	11,081

These figures are probably close approximations, and while they can not be taken as absolute, they will serve to show the general action of deposits. In some cases the lines of soundings across the channel were taken every 100 feet, in others only every 800 feet, but in all cases were carefully taken and well located. Study of detail charts show that usually the single lines 800 feet apart are in the aggregate typical of all and for a general study may be relied on as fairly representing the condition of the whole.

Over the portion of inner section which has not been dredged since 1890, and which is now under contract, we find the following conditions:

Length 4,800 feet—10-foot intervals.	Average depth 1890 after dredging.	Average depth 1893.	In three years.		Average depth 1895.	In two years.	
			Average fill.	Cubic yards.		Average fill.	Cubic yards.
Ten-foot interval from north bank:	*Feet.*	*Feet.*	*Feet.*		*Feet.*	*Feet.*	
First	17	14.3	2.7	4,800	13.3	1	1,778
Second	17.2	14.7	2.5	4,445	13.8	.9	1,600
Third	17.2	14.9	2.3	4,089	14.3	.6	1,067
Fourth	17.2	15.2	2	3,556	15.1	.1	178
Fifth	17.4	15.8	1.6	2,845	15.6	.2	356
Sixth	17.6	16.2	1.4	2,489	16.3	— .1	— 178
Seventh	17.5	16.7	.8	1,422	16.7	.....	.....
Eighth	17.4	16.9	.5	889	17	— .1	— 178
Ninth	17	17	.....	.....	17.4	— .4	— 711
Tenth (mid-channel)	16.8	17	— .2	— 356	17.6	— .6	—1,067
Eleventh (mid-channel)	16.8	16.7	.1	178	17.3	— .6	—1,067
Twelfth	16.9	16.3	.6	1,067	16.8	— 5	— 889
Thirteenth	17	15.7	1.3	2,311	15.8	— .1	— 178
Fourteenth	17	15.4	1.6	2,845	15	.4	711
Fifteenth	17	14.9	2.1	3,734	14.2	.7	1,245
Sixteenth	16.9	14.5	2.4	4,267	13.5	1	1,778
Seventeenth	16.9	14.2	2.7	4,800	13	1.2	2,134
Eighteenth	16.8	14	2.8	4,978	12.7	1.3	2,311
Nineteenth	16.7	13.6	3.1	5,512	12.3	1.3	2,311
Twentieth (next to south bank).	16.2	13.2	3	5,334	11.7	1.5	2,667
				59,561			18,136
				— 356			— 4,268
Total	.....	.....	.....	59,205	.....	.....	13,868

These figures are from lines of soundings not more than 200 feet apart in any case, and represent very closely the actual conditions. It will be noted that the fill in the past two years is less than one-quarter of that in the preceding three years.

Over the bell mouth at junction with the river depths are about the same as in 1893, and are sufficient for all purposes, as all large boats keep the channel closely until deep water in the river is reached.

Maumee River, Lower Crossing.—The U. S. dredge *Maumee* was employed until the end of the season of 1894 on this work. The depth obtained varied from 18 to 21 feet for a width of 300 feet. Soundings taken May 2, 1895, showed these depths to still hold well.

Maumee River, Lake Shore Shoal.—In August, 1894, by your orders, I extended the geodetic survey up the river, making a somewhat complete topographic and hydrographic chart as far up as the Lake Shore Railroad Bridge. A large extent of shoal water was found between Cherry Street Bridge and the Lake Shore Bridge, and by vessels being aground several very bad lumps had been thrown up, so that it was well nigh impassable for large boats. To connect the deep waters above and below this shoal your project of a channel to be dredged 400 feet wide was entered upon by the U. S. dredge *Maumee* this spring. Dredging has thus far been confined to the upper end of the shoal, where most of the lumps were located, and the full widths of 400 feet for a length of about 800 feet has been dredged to a depth of 18 to 21 feet. The remainder of the shoal carries 16 to 16½ feet at mean level and little trouble will now be experienced.

Very respectfully,

WM. T. BLUNT,
Assistant Engineer.

Lieut. Col. JARED A. SMITH,
Corps of Engineers.

Abstract of proposals for dredging in Straight Channel, through Maumee Bay, Toledo Harbor, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Friday, March 1, 1895, at 2 o'clock p. m., standard time, in accordance with advertisement dated February 1, 1895.

[Net amount available for the work, $38,000 to $40,000.]

No.	Name and address of bidder.	Price per cubic yard, scow measurement.		
		For all the dredging called for.	For the inner section.	For the outer section.
		Cents.	*Cents.*	*Cents.*
1	G. H. Breymann & Bros., Toledo, Ohio	12.9	.....	.....
2	Carkin, Stickney & Cram, Detroit, Mich	13.5	.....	.....
3	James Rooney, Toledo, Ohio*	.....	11	13
4	L. P. & J. A. Smith Co., Cleveland, Ohio	25	.....	.....
5	R. J. Cram, Detroit, Mich	27	.....	.....
6	John Stang, Lorain, Ohio	.....	21	21
7	Edward J. Hingston, Buffalo, N. Y	.....	13.5	18.5
8	William James Daly, Ogdensburg, N. Y	12.9	.....	.....

* Lowest bid received.

Recommended that the contract be awarded to Mr. James Rooney, of Toledo, Ohio, his bid, in the aggregate, being the lowest and considered reasonable, and he responsible.

Abstract of contract for improving harbor at Toledo, Ohio, in force during the fiscal year ending June 30, 1895.

[Contract with James Rooney, of Toledo, Ohio, dated March 12, 1895, for dredging in Straight Channel, through Maumee Bay, Toledo Harbor, Ohio.]

Location.	Price per cubic yard, scow measurement.
	Cents.
Inner section	11
Outer section	13

Work still in progress.
Contract time for completion, November 30, 1895.

COMMERCIAL STATISTICS.

The following statistics for the year 1894 relative to the commerce of the harbor at Toledo, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	222,382	Coal	839,000
Coal	118,512	Wheat	382,037
Lumber	169,881	Corn	115,336
Sand	153,300	Flour	43,293
Sugar	13,988	Timber	23,526
Plaster and cement	11,198		
Fruit	1,500	Total	1,403,192
Fish	1,000		
Total	691,761		

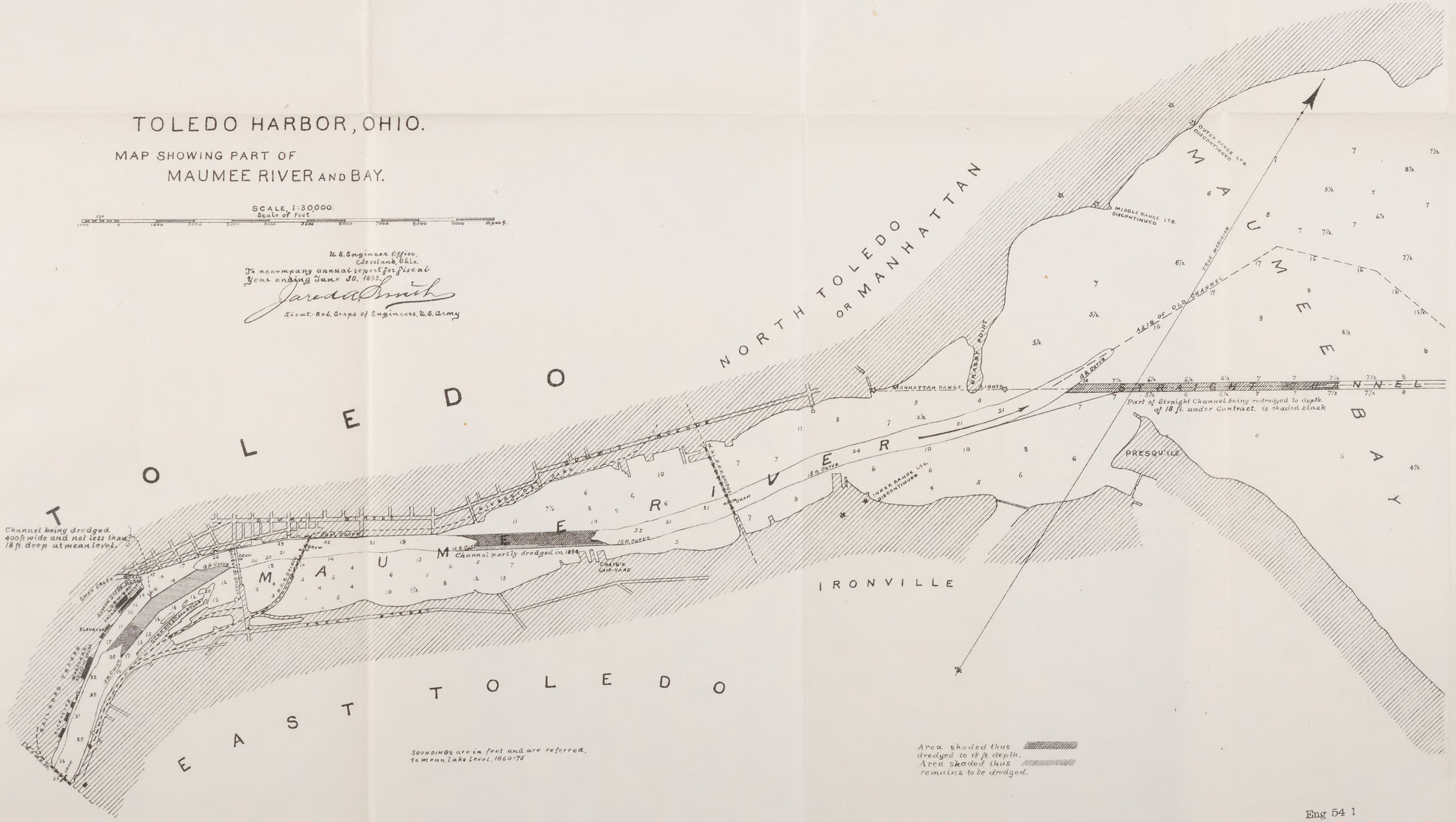
Total freight tonnage:	
1894	2,094,953
1893	1,226,766
Increase	868,187

TOLEDO HARBOR, OHIO.

MAP SHOWING PART OF MAUMEE RIVER AND BAY.

SCALE, 1:30,000.
Scale of Feet

U.S. Engineer Office,
Cleveland, Ohio.
To accompany annual report for fiscal
year ending June 30, 1895.
Jared A. Smith
Lieut. Col. Corps of Engineers, U.S. Army



Eng 54 1

MAP SHOWING PART OF

MAUMEE RIVER AND B

TOLEDO HARBOR, O

SCALE 1:30,000

Vessels.	Number.	Tonnage.
Entering	2,077	966,431
Departing	2,049	957,850

Total registered tonnage:	
1894	1,924,281
1893	1,717,474
Increase	206,807

Draft of largest vessels using harbor, 17 feet. Largest vessels do not load to full depth. Vessels arrive drawing 15½ to 16½ feet which, if fully loaded, would draw 18 to 20 feet.

In 1894 there were ten regular lines of boats leaving Toledo as a terminus carrying merchandise and passengers. Some report at custom-house and some do not as follows:

Name of vessel.	Tonnage.	Trips.	Destination.
Detroit and Cleveland Steam Navigation Line Co.:			
City of Alpena	1,735	Two per week	Toledo to Mackinac.
City of Mackinac	1,750	do	Do.
Grummond's Mackinac Line:			
State of Michigan	736	One per week	Do.
Flora	562	do	Do.
Red Star Line:			
Idlewild	363	One per day	Toledo to Detroit.
Greyhound	621	do	Do.
J. N. Dewey Line:			
Douglass		Two per day	Toledo to Monroe.
Messenger		do	Do.
Wabash Line (merchandise):			
S. C. Reynolds	1,896	Weekly	Toledo to Buffalo.
Geo. J. Gould	2,237	do	Do.
Russell Sage	1,224	do	Do.
J. C. Gault	1,213	do	Do.
Clover Leaf Line (merchandise):			
J. C. Pridgeon, jr	1,212	do	Do.
B. W. Blanchard	1,143	do	Do.
Montreal Line (merchandise):			
Three boats (Canadian)		Irregular	Montreal.
Toledo and Put in Bay Line:			
City of Toledo	1,004	One per day	
Up-river lines (three):			
Four boats		Three per day	

M M 3.

IMPROVEMENT OF PORT CLINTON HARBOR, OHIO.

Previous to 1870 the channel at the entrance to this harbor, which is in the mouth of Portage River, was narrow and crooked, with a depth not exceeding 5 feet. In that year an examination and report was made in compliance with requirement of the river and harbor act approved July 11, 1870.

The sum of $10,000 was expended in 1872 and 1873 in dredging a channel 20 feet wide and 8 feet deep over the bar and constructing a sand fence to prevent filling the channel by drifting sand.

In 1875 it became apparent that the channel could not be maintained without piers and a plan was adopted for constructing piers at an estimated cost of $122,000. A cheaper construction was subsequently adopted and the estimate was modified to $90,000.

Work of dredging and extension of piers was carried on under various appropriations until 1883. The last work upon the east pier was an extension of 150 feet in 1882, and the last work upon west pier was completed August 30, 1883, it being an extension of 150 feet. The subse-

quent appropriations have been applied to repairs, dredging, and purchase of land.

The following is a statement of the amount and date of all the appropriations for this improvement:

July 10, 1872	$8,000	August 2, 1882	$6,000
July 10, 1872 (allotment)	2,000	August 5, 1886	2,000
March 3, 1875	5,000	August 11, 1888	5,000
August 14, 1876	5,000	September 19, 1890	3,000
June 18, 1878	10,000	July 13, 1892	10,000
March 3, 1879	10,000	August 17, 1894	6,000
June 14, 1880	5,000		
March 3, 1881	5,000	Total	82,000

Amount expended to June 30, 1894, $75,315.53.

Of this amount $1,200 was for purchase of the sand point from which the west pier starts, the purchase being made in conformity to act of Congress.

In 1882 the east pier had been extended to a point 2,180 feet from shore, and in 1883 the west pier was extended to a total length of 1,948 feet. These lengths have been found ample for all necessities to the present time. Later expenditures have been mainly for dredging, a few repairs, and for the purchase of land.

The channel is ample for all the present or probable future necessities of the place. The piers are, however, far advanced in decay and are in need of extensive repairs. Funds now available will be expended in repairing the piers during the next fiscal year.

It is recommended that the amount estimated for completion of project be appropriated and applied to completing the repairs.

Port Clinton has no extended commerce. It is a place where there is some local traffic and is a port for extensive fisheries on the lake.

For map of this harbor see Report of Chief of Engineers, 1894, opposite page 2394.

Port Clinton is a port of entry in the collection district of Sandusky, Ohio. The nearest work of defense is Fort Wayne, Mich., 30 miles distant, and the nearest light-house is at Green Island, 10 miles distant.

Money statement.

July 1, 1894, balance unexpended	$2,396.16
Amount appropriated by act of August 17, 1894	6,000.00
	8,396.16
June 30, 1895, amount expended during fiscal year	1,961.88
July 1, 1895, balance unexpended	6,434.28
July 1, 1895, outstanding liabilities	42.20
July 1, 1895, balance available	6,392.08
Amount (estimated) required for completion of existing project	21,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	21,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The following statistics for the year 1894 relative to the commerce of the harbor at Port Clinton, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts:	Tons.
Coal	500
Lumber	5,167
Fish	1,121
Sand	790
Total	7,578

Shipments:

	Tons.
Lumber	383

Total freight tonnage:

1894	7,961
1893	Not given

Vessels.	Number.	Tonnage.
Entering	61	2,658
Departing	56	2,160

Total registered tonnage:

1894	4,818
1893	Not given

Draft of largest vessels using harbor 12½ feet. Largest vessels do not load to full depth. No new lines of transportation have been established during the year.

M M 4.

IMPROVEMENT OF SANDUSKY HARBOR, OHIO.

The harbor of Sandusky, Ohio, is in the lower part of Sandusky Bay The entire bay forms a natural harbor, separated from Lake Erie on the north and northwest by a long, narrow peninsula, and on the northeast by another peninsula, known as Cedar Point. The waters of the bay, which are shallow, being in general but 8 to 12 feet deep, are further protected from the effect of storms on the lake by a bar which extends across the entrance to the bay, except a small distance where the channel passes Cedar Point. The depth of water over the bar is in general from 4 to 6 feet.

Improvements of the channel were first inaugurated in 1826, when an appropriation of $400 was made for a survey. The first appropriation for improvement was made June 11, 1844. The appropriation of August 5, 1886, was the seventeenth for improving the channel, the total amount (excluding survey in 1826) being $280,080.

Under these appropriations improvements were made as necessities required until 1888, when there was a channel of about 15 feet depth across the outer bar, and thence by a considerable detour, following the old channel of deepest water a distance of 3 miles from Cedar Point, to where it reached the channel 15 feet deep and 100 feet wide along the city front.

In 1888 a deeper and more direct channel became necessary and a project was adopted to dredge a straight channel 200 feet wide and 17 feet deep direct from Cedar Point to the east end of channel on city front. The cost of this channel was estimated to be $96,712.

Appropriations were made for this improvement as follows:

By act of August 11, 1888	$40,000
By act of September 19, 1890	45,000
By act of July 13, 1892	41,712
Total	126,712

Of the appropriation of August 11, 1888, $5,000 was made applicable to the old channel, and the sum of $8,727.17 from the next appropriation was similarly expended.

Expenditures on both channels, 1888 to June 30, 1894, including contingencies	$112,777.88

At the close of the last fiscal year dredging was in progress under a contract for completion of the straight channel and the work was nearly finished.

Expenditures in last fiscal year, including liabilities..... $33,947.53

Dredging was continued upon the straight channel until August 31, 1894, when it was completed. The amount dredged from July 1 to August 31, 1894, under the contract was 67,664 cubic yards.

The expense of the channel, including all contingencies, was..... $112,984.83

Part of the excess over the original estimate was due to the fact that prices by contract averaged higher than they were estimated and to the fact that the number of cubic yards dredged was greater than the estimate because of fill from sliding in of banks or drift before the work was completed.

The appropriation of August 17, 1894, was for "continuing improvement, $30,000, $5,000 of which may be used in removing shoal at outer approach to harbor, and the Secretary of War is authorized and directed, in his discretion, to cause a survey, if necessary, for the purpose, and an estimate to be made of the cost of further necessary improvement of said harbor, including the channel over said outer bar."

A project for expenditure of funds in this appropriation was submitted in a letter of which the following is a copy:

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, August 22, 1894.

GENERAL: In compliance with request in Department letter dated August 20, 1894, giving notice of appropriations for rivers and harbors, I have to submit the following project for expenditure of $30,000 for improving harbor at Sandusky, Ohio.

The approved project for a straight channel at Sandusky Harbor is now nearly completed, and in a few days it will be completed by dredges now employed under a formal contract. I inclose herewith a tracing from a map of Sandusky Harbor to explain this project for expenditure.

The straight channel is between the outer bar and the channel along city front known as the dock channel. Both the outer bar and dock channel are in such bad condition from shoaling that vessels can not enter nor leave the harbor properly loaded. Yesterday a large vessel was aground on the bar. The necessity for immediate relief has been most urgently represented to this office by parties interested in the commerce of Sandusky.

In order to continue the improvement in such manner as to give an immediate benefit I recommend, first, that the amount of $5,000, which is authorized to be expended on the outer bar, shall be expended in dredging to a depth of 18 feet in the channel marked in red on the tracing. It is estimated that this channel may be made 100 feet wide and 18 feet deep with the funds available.

I recommend that the balance of the appropriation ($25,000) be expended in dredging the channel along the dock front, as shown in red on the tracing, to a depth of 17 feet. The amounts to be expended, as indicated above, include all contingencies of office and superintendence.

The parties now doing the work are willing to continue the dredging on inside channels at the same rates as are now received under the contract which was let at an exceptionally low rate for that place (13½ cents per yard) after advertising. The same parties will immediately dredge the bar at 16 cents per yard.

It is therefore recommended as being the most economical and advantageous method of expenditure to carry on the improvement by hired labor and purchases in open market, thus continuing the work without interruption and obtaining exceptionally low prices.

If done by contract it is not probable that any better prices can be obtained, and a very great delay would necessarily obtain involving inconvenience and great loss to the shipping interests.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

The recommendation was approved, and as a result the two dredges which had been employed upon the straight channel continued at work without interruption. August 30, 1894, one of the dredges commenced work on the outer bar. This part of the work was continued, when weather permitted, until December 11, when work was suspended for the winter. Dredging on the dock channel was commenced September 1, and continued until December 11, 1894. Operations were resumed with a single dredge May 18, 1895, and continued, except an interruption of about one week, until the end of the year.

The amounts thus far removed are as follows:

From bar, 14,404 cubic yards, at 16 cents	$2,304.64
From dock channel, 74,641 cubic yards, at 13½ cents	10,076.55
Removing bowlders in dock channel, 22 hours 55 minutes	256.56
Total	12,637.75

Work upon the channels will be continued until available funds are expended.

Expenditures upon the work since completion of straight channel, including liabilities	$13,522.77

In compliance with the requirements of the river and harbor act of August 17, 1894, a report was submitted to the Chief of Engineers under date of December 1, 1894, giving a statement of the improvements necessary for Sandusky Harbor and an estimate of the expense. The estimated amount to complete the improvements was $225,000, in addition to amount of $30,000 appropriated August 17, 1894; total, $255,000.

The report was published in House Ex. Doc. No. 91, Fifty-third Congress, third session.

As this document is essential to a proper understanding of the situation at Sandusky Harbor, a copy is appended hereto as part of this report, with request that it be published with the accompanying map. The straight channel will be marked by range lights, which are now being constructed under direction of the Light-House Board.

In June, 1895, Mr. William T. Blunt, assistant engineer, made a hydrographic survey of the channels at Sandusky Harbor; the soundings have been platted, and drawings of sections have been made to afford a study of the fill and probable cost of maintenance. Considering all the conditions the fill has not been very great. The banks were left with the natural slope, and it was expected that they would wash into the channel somewhat under the action of waves and the force of water thrown from the wheels of passing steamers. The fill will naturally become less as the channel banks become more nearly horizontal.

For a more complete explanation of the depths and the fill in the channel Mr. Blunt's report is appended with the sheet of typical cross sections, to which attention is invited.

Sandusky Harbor is in the collection district of Sandusky, Ohio. There is a lighthouse on Cedar Point, with a fixed white light of the fifth order, and three range lights within the bay. Fort Wayne, Mich., below Detroit, is the nearest work of defense.

Money statement.

July 1, 1894, balance unexpended	$20,391.81
Amount appropriated by act of August 17, 1894	30,000.00
Deposited by L. C. Overman	25.00
	50,416.81
June 30, 1895, amount expended during fiscal year	32,125.84
July 1, 1895, balance unexpended	18,290.97
July 1, 1895, outstanding liabilities	1,821.69
July 1, 1895, balance available	16,469.28
Amount (estimated) required for completion of existing project	225,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT ON THE COST OF FURTHER NECESSARY IMPROVEMENT OF HARBOR AT SANDUSKY, OHIO, INCLUDING THE CHANNEL OVER THE OUTER BAR.

[Printed in House Ex. Doc. No. 91, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 4, 1894.

SIR: The river and harbor act of August 17, 1894, in the item containing an appropriation for improving harbor at Sandusky, Ohio, authorizes and directs the Secretary of War, in his discretion, to cause a survey, if necessary for the purpose, and an estimate to be made of the cost of further necessary improvement of said harbor, including the channel over said outer bar.

Instructions having been given by the Secretary of War for the preparation of plans and estimates of cost of improvement contemplated by the act, I have now to submit the accompanying copy of report of December 1, 1894, on the subject by Lieut. Col. Jared A. Smith, Corps of Engineers, in which he presents an estimate amounting to $225,000 as the sum required to complete the improvements proposed.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, December 1, 1894.

GENERAL: In compliance with request in letter dated September 20, 1894, I submit a plan and estimate of cost of further necessary improvement of Sandusky Harbor, Ohio, including the channel over the outer bar.

For the purpose of making a plan and estimate of the cost of further necessary improvements, the maps now in the office are considered to be sufficiently near to represent all essential conditions. The conditions are, however, subject to more or less of variation from time to time, so that an estimate of quantities, based upon soundings at any definite time, would be subject to corresponding modification before the work could ordinarily be completed.

The maps from latest surveys are therefore considered as good for the purpose as though made from a special survey at this time.

The last project of improvement, which was completed during the season of 1894, consisted of a straight channel 200 feet wide on the bottom and 17 feet deep from Cedar Point to the easterly extremity of the dock channel. No work for maintenance or improvement had, until recently, been done upon the outer bar nor upon the dock channel for several years, and during that time various causes operated to fill the channels. The channel over the outer bar was not only narrow but was crooked, and only a portion of it was marked by the range lights on Cedar Point, so that vessels could not follow the line of deepest water and they frequently went aground.

The dock channel had become very shoal in some places, and vessels drawing to exceed 13 feet found great difficulty in reaching any of the upper wharves. As none of the wharves can be reached by steamers from the lake without passing over the outer bar, and but few can be reached without traversing more or less of the dock channel, the completion of the straight channel intermediate between the outer bar and dock channel can not produce any important result until the other channels are improved.

To accompany and explain this report I forward, in a separate package by this mail, a tracing of a chart of Sandusky Bay,* showing the location of the various channels and of the further improvements which are considered necessary.

To make a plan of improvement for Sandusky Harbor which shall afford a permanent channel of good depth over the outer bar may perhaps be a problem which can not be definitely solved in advance, but after a most careful study of both general and local conditions the plan recommended is believed to be as good as can be devised. The general features in outline and depth in the lower part of Sandusky Bay are shown upon the map.*

The natural outflow into Lake Erie, due to tributaries flowing into Sandusky Bay, is too small to produce any scouring effect upon the bar, which is about 1½ miles long between Cedar Point and Sand Point. That there is a very strong current and consequent scour at times from some cause is at once apparent on examining the map. Across the end of Cedar Point, and nearly at right angles thereto, is a channel about 400 feet wide and nearly 1 mile in length where the depth exceeds 18 feet, and in the middle directly opposite the point of land the depth is as great as 40 feet. Effects of the currents through this channel, known as the "Deep Hole," are shown in the contours on the bars at both its extremities.

The outer end of the new straight channel is entered from the "Deep Hole" and the shallow part of outer bar is between the "Deep Hole" and the deep water of the lake. This is the place where the deepest channel is needed. A channel of 17 feet depth inside, where the water is smooth, will safely float a vessel of nearly 17 feet draft of water, but

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* Omitted. Printed in House Ex. Doc. No. 91, Fifty-third Congress, third session.

the same vessel would strike the bottom on the bar in a much greater depth when crossing it with a heavy sea from the lake. The same principle is true with respect to width. In still water vessels may be easily handled in a comparatively narrow channel, but in such a channel reached by seas from the lake they can not be safely guided.

An interesting phenomenon in Lake Erie is the great change in the level of the surface at various points owing to the direction of the winds. All strong easterly winds raise the level of the lake at Sandusky, and in fact, in nearly all the westerly half of the lake, while lowering the level at easterly points. All strong westerly winds lower the level of the lake at Ashtabula and at all points westward (as observed on the south shore) and raise the level at Conneaut and all points eastward.

In easterly winds at the entrance to Sandusky Bay the currents along the shore are very slight, and the rising water of the lake flows over the entire bar between Cedar Point and Sand Point, thus raising the level of the water in the upper and lower bays. When a strong wind blows from west or northwest points, the currents along the shore from west to east at all points from Ashtabula westward are very strong and the surface level falls rapidly.

At Monroe, in the west end of the lake, the level has fallen 7 feet below the mean level twice in the past two years, and has risen about 5 feet above mean level as the effect of winds. These results occur in the space of a few hours.

At the entrance to Sandusky Bay the difference of level from winds is less than at Monroe, but it is sufficient to produce very great effects.

The rapid lowering of the lake level in heavy westerly winds causes the water to flow with a strong current from the bay into the lake, and the shore currents from west to east, aided by the contours of the bay, control the outflowing waters in such way as to scour the "Deep Hole" channel.

After giving the matter much observation and study, I have concluded that if Cedar Point were widened toward the lake, or the same effect were produced by a jetty from Cedar Point into the lake, the "Deep Hole" would surely be extended in the same direction. The encroachments on the channel over the bar come from the westward, and it is probable that at some future day a detached dike or breakwater on the west side may be found necessary to protect the channel.

The locations of the jetty and dike are shown upon the map. It is proposed to construct these works of brush mattresses loaded with heavy riprap stone.

The further improvements which are essential to the business of Sandusky Harbor are, as before indicated, a better channel over the bar and a deeper and wider channel along the city front over the line of old dock channel.

The channel over the bar should have a width not less than 300 feet and a depth not less than 18 feet; a greater depth is desirable, but it is perhaps too much to count upon at present. The channel along the dock front should have a width of 200 feet and a depth not less than 17 feet.

The straight channel at its outer end shows effects of shoaling by the currents which run obliquely across the channel at that place. To obviate some of the effects of the currents it is therefore proposed to widen the straight channel at that end. At the inner end of straight channel a similar widening is necessary, to prevent interference or collision with vessels at the wharves outside the bend. The straight channel thus far dredged is 200 feet wide on the bottom, with natural

slopes. As soon as this channel is much used by steamers the banks will wash down, making flatter slopes and narrowing the channel of 17 feet depth. To give the channel of 17 feet depth a permanent width of 200 feet will therefore require dredging along the outer edges as the slopes are washed down. An estimate for this dredging is included with that for further necessary improvements.

The river and harbor act of August 17, 1894, made an appropriation of $30,000 for continuing the improvement of Sandusky Harbor, and provided that $5,000 of the amount may be used in removing shoal at outer approach to harbor.

A recommendation to expend the appropriation in improving the channel over outer bar and the dock channel, by dredging, was approved by the Chief of Engineers, and that work is now in progress.

The amount remaining to complete the improvements here recommended, after expenditure of the appropriation of August 17, 1894, is estimated as foliows:

Dredging channel 300 feet wide and 18 feet deep over outer bar, 200,000 cubic yards, measured in scows, at 18 cents	$36,000
Constructing jetty, 2,500 feet long, at $20	50,000
Constructing dike, 2,500 feet long, at $25	62,500
Dredging straight channel slopes and widening at both ends, 200,000 cubic yards, at 14 cents	28,000
Dredging dock channel, 6,500 feet long, to width of 200 feet and depth of 17 feet, 200,000 cubic yards hard material and stones, at 16 cents	32,000
Engineering, superintendence, etc	16,500
Total	225,000

It should be observed that this estimate covers original cost of construction only, and does not provide for expense of maintenance by dredging or otherwise.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. WILLIAM T. BLUNT, ASSISTANT ENGINEER.

CLEVELAND, OHIO, *June 30, 1895.*

SIR: I have the honor to transmit herewith tracings relating to Sandusky Harbor, Ohio, as follows:

Soundings on outer bar, May and June, 1895.*
Soundings on straight channel, June, 1895.*
Soundings on dock channel, May, 1895.*
Soundings on dock channel, short line extension, June, 1895.*
Typical cross sections on straight channel, and to make the following report upon the same.

All depths herein mentioned are at mean level of Lake Erie, 1860–1875, which is the datum plane used on Lake Survey charts.

Outer bar.—The channel dredged in 1894 under contract shows now from 17 to 21 feet depth. All that dredging was done within the lines of the recently approved project for a straight cut while following the channel now in use. The Light-House Board has so altered the positions and increased the number of channel buoys that no trouble should be experienced in crossing the bar. Even with the water 1 foot below mean level, as it is this year, there is everywhere a channel of 16½ feet, and while without doubt this portion of the work should be deeper than that inside the harbor, it is probable that the small appropriation available this season will be more advantageously used on the inner harbor.

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* Not forwarded.

Straight channel.—The original dredging of this channel was only completed in the fall of 1894; that is, the entire area had then been dredged. Owing to small appropriations the work had been distributed over many seasons, and the resulting depths are not as regular as might otherwise be expected. Soundings were taken over the entire length on June 14 and 18, 1895, and are shown on tracing. Over the greater part the depths are from 17 to 19 feet, and where less than 17 feet we generally find 16 feet and better, with narrow ridges having 15 to 16 feet. Material is sand, gravel, and mud, and these ridges will tend to dissipate into the deeper portions.

On the sheet of "Typical cross sections" the length of the channel is divided into three portions, viz: The mouth, at junction with "Deep Hole" outside the "Middle Ground," a length of 800 feet; the bar, through the crest of the "Middle Ground," 2,400 feet long; inside the bar, from the "Middle Ground" across the flat bay to the city front.

Over the first-mentioned 800 feet no dredging has been done since November, 1893, so that we can compare three sets of soundings. There is a fill over this area of a little over 1 foot since November, 1893, apparently through a tendency of the "Deep Hole" to rebuild its walls. A fill of nine-tenths of a foot occurred between November, 1893, and June, 1894, while in the past year, June, 1894, to June, 1895, the fill was only two-tenths of a foot. This may indicate the approaching limit of current scour.

In contrast with this, we find on the other two portions above mentioned—through the bar with 4 to 5 feet depth on its crest and across the bay to the city front—practically no change either in the banks or bottom during the nine, eleven, or twelve months elapsed since dredging. The soundings of 1894 were made either in June, July, or September after dredges had finished in various localities, so that they fairly represent the condition as left by dredging. Making due allowance for slight imperfections in location, it is quite remarkable how the two sets of sections follow each other.

Quite strong currents through the channel are induced by strong winds, and it is seldom that a movement can not be detected either in or out. It is quite probable that the currents are sufficient to usually keep the channel clear (as was indicated when soundings of July 1, 1893, were found to show from 16 to 18 feet depth, no dredging having been done since October, 1891), until near entrance to Deep Hole, where countercurrents are met to cause eddies and shoaling.

The following tabular statement is based on the same soundings as is the chart of cross sections:

AT MOUTH.

	1893.		1894.		1895.	
	Number of soundings.	Average depth.	Number of soundings.	Average depth.	Number of soundings.	Average depth.
		Feet.		*Feet.*		*Feet.*
Line 0+200	22	17.5	20	16.5	18	16.2
+400	18	17.4	18	16.5	21	16.2
+600	21	17.2	22	16.2	18	16.2
+800	20	17.2	17	16.5	20	16.2
Total	81	17.33	77	16.43	77	16.21

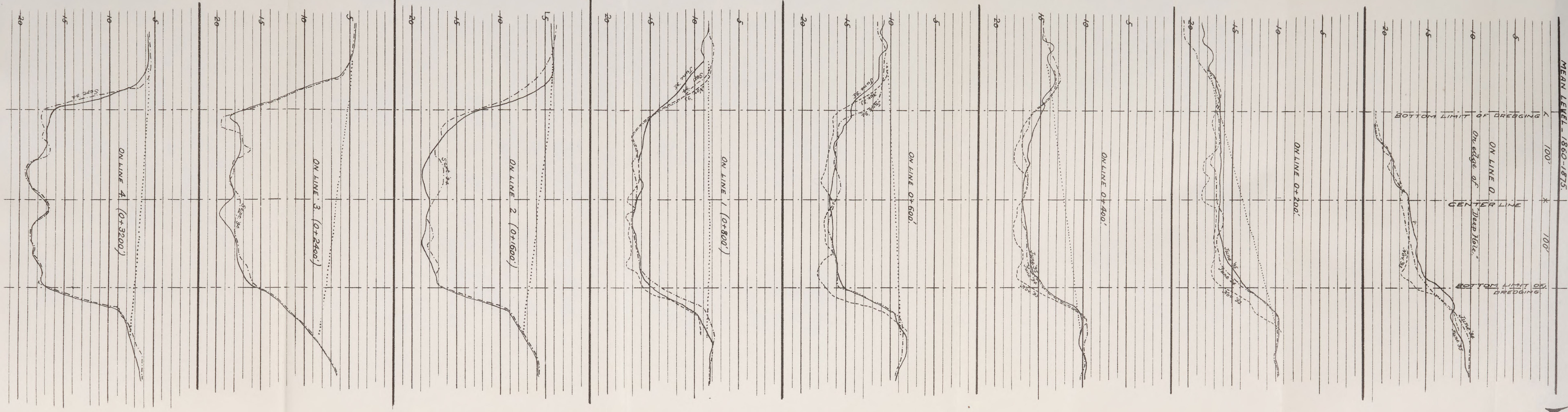
THROUGH BAR AND BAY.

	1894.		1895.	
	Number of soundings.	Average depth.	Number of soundings.	Average depth.
		Feet.		*Feet.*
Line 2, 0+1600 Bar	19	17.2	19	17.5
3, 0+2400 Bar	19	17.8	22	18
4, 0+3200 Bar	21	17.9	21	17.8
5, 0+4000 Bay	22	17.7	21	17.5
6, 0+4800 Bay	21	17.6	19	17.6
7, 0+5600 Bay	18	17.0	22	17.2
8, 0+6400 Bay	21	17.4	20	17.1
9, 0+7200 Bay	20	17.6	20	17.2
10, 0+8000	20	17.5	19	17.3
11, 0+8800 Bay	18	17.2	20	17.2
Total	199	17.48	203	17.43

These lines are selected at regular intervals and are indicative of the condition of entire channel.

THROUGH BAR.

AT MOUTH OF CHANNEL, BETWEEN BAR AND DEEP HOLE



U.S. Engineer Office.
Cleveland, Ohio.
To accompany annual report for fiscal year ending June 30, 1895.

Jared A. Smith
Lieut-Col. Corps of Engineers, U.S. Army

SANDUSKY HARBOR, OHIO. STRAIGHT CHANNEL.

TYPICAL CROSS-SECTIONS.

CROSS SCALE 1:1000.
VERTICAL SCALE 1:100.

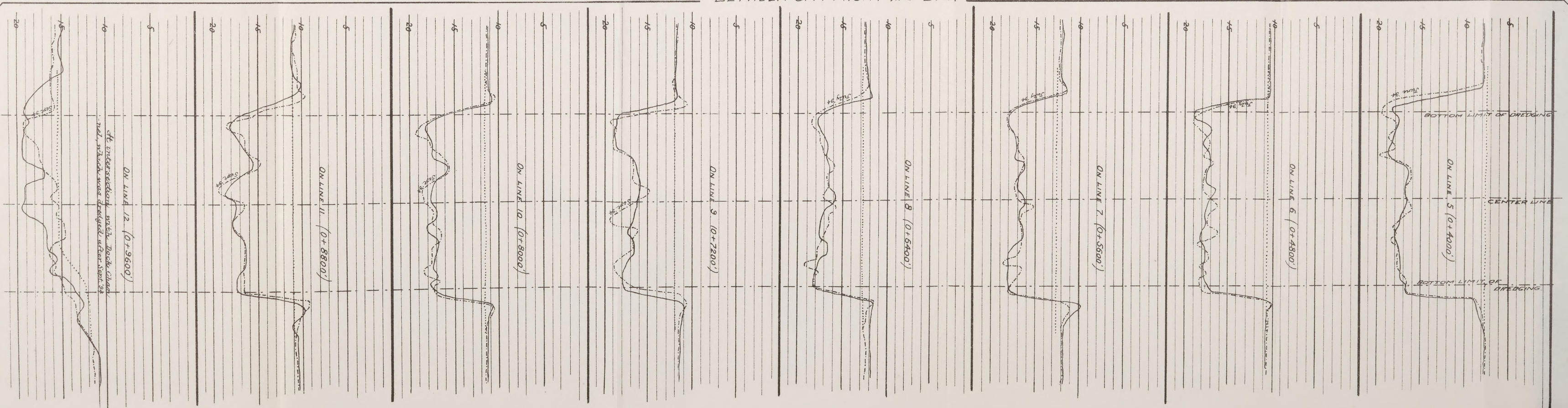
To accompany Report of this date to Lieut-Col. Jared A. Smith, Corps of Engrs. U.S.A.
June 30 1895.

Wm. T. Blunt Asst. Engr.

..... Bottom before dredging
- - - - - " immediately after dredging, Nov. '93, at Mouth of Channe
-.-.-.- " " " " June, July or Sept, '94.
No dredging at Mouth of Channel after Nov. '93.
—— Present bottom, June, '95.

TRUE MERIDIAN

BETWEEN CITY FRONT AND BAR



Eng 54 1

Dock channel.—The channel has been redredged during the past fiscal year to a width of 89 feet from its junction with the straight channel at the Baltimore and Ohio Railroad wharves westward along the city front to Ayers Wharf. Depths are now 17 to 20 feet. Its extension westward to the Columbus, Sandusky and Hocking Railroad (commonly called the "Short Line") wharves, 2,700 feet, having been approved in December, 1894, the dredge, under contract with Carkin, Stickney & Cram Company, is now at work on this extension. In 1892 the Short Line dredged a channel 60 feet wide and 18 feet deep to connect the old dock channel with their wharves. This cut has now filled so that along its center line there is about 15 to 16 feet depth, with 14 to 15 on the sides. This cut will first be cleared out to make it available for present needs of commerce before the work of widening begins.

Very respectfully,

WM. T. BLUNT, *Assistant Engineer.*

Lieut. Col. JARED A. SMITH,
Corps of Engineers.

COMMERCIAL STATISTICS.

The following statistics for the year 1894, relative to the commerce of the harbor at Sandusky, Ohio, were compiled from information furnished by the collector of customs and others:

Articles.	Tons.	Articles.	Tons.
RECEIPTS.		SHIPMENTS.	
Lumber	63,548	Coal	356,613
Iron ore	26,868	Merchandise	11,712
Sand	60,000		
Pulp wood	43,720	Total	368,325
Stone	26,250		
Merchandise	8,675		
Fish	2,468		
Pig iron	600		
Total	232,129		

Total freight tonnage:

1894	600,454
1893	424,280
Increase	176,174

Vessels.	Number.	Tonnage.
Entering	3,142	655,400
Departing	3,175	664,000

Total registered tonnage:

1894	1,319,400
1893	1,524,183
Decrease	204,783

Draft of largest vessels using harbor, 17 feet. Largest vessels do not load to full depth. No new lines of transportation have been established during the year.

M M 5.

IMPROVEMENT OF SANDUSKY RIVER, OHIO.

The Sandusky River rises in Richland County, Ohio, and empties into the upper end of Sandusky Bay, about 14½ miles by the channel of the bay to Lake Erie.

Fremont, at the head of navigation, 18 miles from the bay, is a city of about 9,000 inhabitants and the market town of a large area.

In 1867 and 1872 appropriations amounting to $30,000 were made for improving the river.

In 1880 a project was adopted for dredging a channel 100 feet wide and 9 feet deep through several bars between Fremont and the depth of 9 feet in Sandusky Bay. The estimated cost was $44,000.

The following appropriations were made after the adoption of the project:

June 14, 1880	$10,000.00
March 3, 1881	7,500.00
August 2, 1882	4,000.00
September 19, 1890	1,500.00
July 13, 1892	5,000.00
Total	28,000.00
Amount expended and incurred to June 30, 1894	27,859.04
Expended in last fiscal year	140.96

The improvements thus far have consisted in dredging through bars, the largest part of which is at the mouth of the river. The dredging has been done in installments at intervals of from one year to eight years, and as a result some of the places first dredged had refilled and required redredging before other parts had been reached.

The last dredging through the bar at mouth of the river was late in the season of 1893, when a narrow channel was dredged to a depth of 10 feet. In June, 1894, less than two years, the channel over bar had filled from 1 foot to 1½ feet since it was dredged.

The channels would doubtless remain longer were there frequent passing steamers to keep the bottom stirred up; the traffic is, however, so small as to be hardly worth a mention.

To make a good, navigable channel from the bay to Sandusky would now require as much labor as it would have done before any appropriation had been expended, and to render any such channel reasonably permanent would require some works of construction to change the existing conditions. The cost of such works would far outweigh any possible benefits.

There is really no commerce on the river, and the passage of a boat with freight or passengers is so unfrequent that the cost of maintaining a channel of 9 or 10 feet depth would be more than the total receipts for freight and passengers.

The expenditures of the last year have been mainly for expenses of the previous year, and the small balance has been expended for necessary examination and office work.

Fremont, the head of navigation, is in the collection district of Sandusky, Ohio. The nearest light-house is at Cedar Point, the entrance to Sandusky Bay. Fort Wayne, near Detroit, Mich., is the nearest work of defense.

Money statement.

July 1, 1894, balance unexpended	$550.07
June 30, 1895, amount expended during fiscal year	550.07

M M 6.

IMPROVEMENT OF HURON HARBOR, OHIO.

The Huron River empties into Lake Erie at a point about 10 miles east of Sandusky.

In 1826, when the mouth of the river was closed by a sand bar, a plan of improvement was adopted, consisting of parallel piers 140 feet

apart to confine and protect the channel. The plan was modified and extended from time to time as the demands of commerce required.

Previous to the approval of latest plan in 1890, twenty-two appropriations had been made and expended for this improvement. The aggregate of these appropriations from 1826 to 1888, inclusive, was $123,273.71.

The expenditure of this sum had resulted in extending the piers to a depth of about 14 feet in the lake, in the maintenance of piers and channel for more than sixty years, and in a recent dredging of channel to a depth of 15.7 feet.

It should be explained that the contours of depth in the lake vary in position somewhat from year to year, especially in the vicinity of the mouths of streams which bring down sand and mud, and near piers which stop the movement of drift along the shore.

The river and harbor act of September 19, 1890, appropriated for "Improving harbor at Huron, Ohio: Continuing improvement in amended project to give 16 feet depth at low water, $16,000."

In compliance with this act a plan and estimate of cost of extending piers to a depth of 16 feet in the lake was made in 1890, and revised in 1893, after 240 feet of the pier had been completed.

The revised estimate is as follows:

Extending east pier 640 feet, and west pier 600 feet, 1,240 feet, at $92...	$114,080
Contingencies of all kinds	10,920
Total for work remaining to be done in 1893	125,000
To this should be added actual cost of 240 feet built in 1891 and 1893 (see Report of Chief Engineers, 1894, p. 2401)	20,000
Total	145,000

This estimate has of necessity covered only the original cost of piers, leaving repairs and maintenance of channel to be provided for from available funds whenever necessary.

Appropriations for this work have been made as follows:

By act of September 19, 1890	$16,000.00
By act of July 13, 1892	15,000.00
By act of August 17, 1894	10,000.00
Total	41,000.00
Amount expended and incurred to June 30, 1894	29,856.55

In addition to the extension of 80 feet to east pier, and 160 feet to west pier, the superstructure of west pier had been entirely rebuilt in two places, 180 feet long and 108 feet long, respectively; some minor repairs had been made, and the channel had been dredged to the full depth of 16 feet in 1891.

Amount expended and incurred in last fiscal year	$1,170.11

July 1, 1894, a contract for dredging the bar was outstanding with Messrs. Sadler & Allen, of Detroit, Mich. Dredging was commenced July 2, and completed July 14, 1894. The channel over the bar was deepened to 17 feet by the removal of 4,000 cubic yards of material. This is the first dredging at Huron since 1891, which indicates that in point of freedom from bars the conditions at Huron Harbor are exceptionally favorable.

On January 21, 1895, proposals were invited by public advertisement for extending the east pier at Huron 72 feet.

Bids were opened February 12, 1895, and a contract for the work was awarded to Mr. John Stang, of Lorain, Ohio, in connection with the similar work at Black River Harbor. On June 30, 1895, the contractor had completely constructed the single crib 72 feet long and it was ready to sink as soon as stone should be received. Great advantage has resulted at other places from making the cribs as long as practicable, and the only limit of length which will be advantageous is such as is caused by the practical difficulty of sinking in place and filling with stone in a single day. At Ashtabula Harbor, in 1893, a length of 240 feet was placed in a single crib to great advantage. At Huron Harbor the limit of length has been determined by the cost. Heretofore in constructing extensions to piers it has been customary to build the superstructure of the new work to extend over the old by "racking back." This was done to secure the end of new work in such manner as to prevent lateral movement. The method, however, adds to the expense and introduces the fault that the cribs of the new work in settling may be separated from the superstructure which is supported at one end upon work previously built. Injury from this cause has been observed, so that the new works are now made to abut fairly without joining the old.

Of the last appropriation it is proposed to expend about $7,500 upon the project for extension of piers, and the remaining $2,500 upon such dredging as may be needed and upon repairs. The extension of piers will be completed on or before the end of August.

A survey of the channel made in June, 1895, showed that between the piers the depths generally exceeded 18 feet except at the outer end where the depth was but 17.3 feet. A small bar was found forming outside the end of east pier and extending across the channel with a least depth of 14.7 feet on the side and 15.8 feet in mid-channel. Dredging to some small extent will doubtless be required during the ensuing year.

Huron Harbor is in the collection district of Sandusky, Ohio. Fort Wayne, Mich., about 70 miles distant, is the nearest work of defense. There is a fixed white light of the fourth order on the outer end of the west pier.

Money statement.

July 1, 1894, balance unexpended		$1,160.12
Amount appropriated by act of August 17, 1894		10,000.00
		11,160.12
June 30, 1895, amount expended during fiscal year		1,071.44
July 1, 1895, balance unexpended		10,088.68
July 1, 1895, outstanding liabilities	$98.67	
July 1, 1895, amount covered by uncompleted contracts	6,390.86	
		6,489.53
July 1, 1895, balance available		3,599.15
Amount (estimated) required for completion of existing project		117,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of proposals for extension of pier, improving harbor at Huron, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Tuesday, February 12, 1895, at 2 o'clock p. m., standard time, in accordance with advertisement dated January 21, 1895.

[Net amount available for the work, $7,500.]

No.	Name and address of bidder.	Hemlock timber.	White pine timber.	White oak timber.	Stone, per cord.	Iron plates, per pound.	Drift-bolts, per pound.	Spikes, per pound.	Screw bolts and washers, per pound.	Dredging cuts, per cubic yard.	Total.
1	Quartus A. Gillmore, Lorain, Ohio	$23.00	$33.00	$40.00	$5 75	$0.06	$0.03	$0.04	$0.04	$1.00	$6,425.26
2	John Stang, Lorain, Ohio	23.00	33.00	40.00	5.75	.04	.03	.04	.04	.95	6,390.86

Recommended that the contract be awarded to Mr. John Stang, of Lorain, Ohio, at the rates named in his proposal, his bid, in the aggregate, being the lowest and considered reasonable.

Abstract of contract for improving harbor at Huron, Ohio, in force during the fiscal year ending June 30, 1895.

Contract with John Stang, of Lorain, Ohio, dated March 4, 1895, for furnishing the material and doing the work required for extension of pier on the east side a distance of 72 feet or more.

Timber and plank, per M feet, B. M.:	
Hemlock	$23.00
White pine	33.00
White oak	40.00
Stone, per cord of 128 cubic feet	5.75
Iron, per pound:	
Plates	.04
Driftbolts	.03
Spikes	.04
Screw bolts and washers	.04

Work still in progress.
Contract time for completion, September 30, 1895.

COMMERCIAL STATISTICS.

The following statistics for the year 1894 relative to the commerce of the harbor at Huron, Ohio, were compiled from information furnished by the collector of customs and others:

	Tons.
Receipts:	
Iron ore	193,699
Lumber	2,788
Pound poles	106
Total	196,593
Shipments:	
Coal	285,000
Total freight tonnage:	
1894	481,593
1893	425,032
Increase	56,561

Vessels.	Number.	Tonnage.
Entering	144	146,653
Departing	149	146,421

Total registered tonnage:	
1894	293,074
1893	228,947
Increase	64,127

Draft of largest vessels using harbor, 16½ feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

M M 7.

IMPROVEMENT OF VERMILION HARBOR, OHIO.

The Vermilion River rises in the northern part of Ohio and empties into Lake Erie about 20 miles to the eastward of Sandusky.

In 1836 there was less than 2 feet of water over the bar at the mouth of the river, and a project was adopted to extend parallel piers 125 feet apart over the bar into the lake. This was amended from time to time until the piers were extended to a depth of 12 feet in the lake in the spring of 1874. The east pier was then 1,075 feet and the west pier 1,125 feet in length. In the same year a project was adopted to remove rock and other material between the piers and into the lake to afford a depth of 14 feet over a width of 100 feet. This was completed in 1879.

The work thus far was carried on under eleven appropriations, from 1836 to 1878, inclusive, amounting in the aggregate to $113,701.28.

Since that time the channel depth has varied from time to time, but it is rarely less than 12 feet at mean lake level.

Since 1879 all expenditures have been for repairs.

There is no project for further improvement, because the present commerce of the place is very small and is not growing. It is, however, considered advisable to keep the piers in repair.

Since the completion of the improvement in 1879 the following appropriations have been made, and all except the last have been expended for repairs.

June 14, 1880	$2,000	September 19, 1890	$2,000
March 3, 1881	2,000	July 13, 1892	2,000
August 2, 1882	3,000	August 17, 1894	2,000
August 5, 1886	3,000		
August 11, 1888	1,000	Total	17,000

There have been no works of repair in the last fiscal year, the small expenditure being for a necessary examination of the condition of the piers. The funds now available will be expended during the ensuing year in repairing superstructure of piers.

The channel depths between the piers at Vermilion vary less than at most other places on the lake. No bars have formed since the completion of piers. The depth of water in the channel at mean water level is from 12 to 14 feet, which is enough for the very small business of the place.

It is recommended that the balance estimated to complete the repairs be appropriated in a single sum for that purpose.

Vermilion Harbor is in the collection district of Sandusky, Ohio. There is a fixed light of the fifth order on the west pier. Fort Wayne, Mich., 80 miles distant, is the nearest work of defense.

Money statement.

Amount appropriated by act of August 17, 1894	$2,000.00
June 30, 1895, amount expended during fiscal year	2.45
July 1, 1895, balance unexpended	1,997.55
Amount (estimated) required for completion of existing project	4,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	4,000.00
Submitted in compliance with requirments of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The following statistics for the year 1894 relative to the commerce of the harbor at Vermilion, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Fish	1,500	Fish	1,500
Lumber, etc	73	Fishing-tackle	200
Total	1,573	Total	1,700

Total freight tonnage:

1894	3,273
1893	4,304
Decrease	1,031

Vessels.	Number.	Tonnage.
Entering	55	650
Departing	53	600
Built (tugs)	2	25

Total registered tonnage (vessels entering and departing):

1894	1,250
1893	15,100
Decrease	13,850

Draft of largest vessels using harbor, 11 feet. Largest vessels loaded to full depth. No new vessel lines established during the year.

M M 8.

IMPROVEMENT OF BLACK RIVER HARBOR, OHIO.

This harbor is in the township and city of Lorain, where the Black River empties into Lake Erie. In its natural condition the river had a depth of but about 3 feet on the bar at its mouth.

In 1828 an improvement was undertaken by confining the channel between parallel piers extending over the bar into the lake. The project was modified and extended from time to time as the demands of commerce increased.

In 1891 the officer in charge of the improvement submitted a recommendation to extend the parallel piers to a depth of 17 feet in the lake. The project was approved in 1893, the estimated cost being as follows:

Extending piers to a depth of 17 feet in the lake:

Two piers, 280 feet each, 560 linear feet, at $91.10	$51,016
Contingencies of all kinds, less than 10 per cent	4,984
Total	56,000

Previous to the adoption of latest project there had been twenty-six appropriations for improving this harbor, the aggregate amount (all expended) being $232,204.77.

The piers had been extended to a depth of 16 feet in the lake, and the channel between piers generally exceeded 16 feet in depth.

Appropriations for this improvement have been made as follows:

By act of July 13, 1892	$20,000.00
By act of August 17, 1894	10,000.00
Total	30,000.00
Amount expended since adoption of last project to June 30, 1894, construction, repairs, and dredging	19,773.07
Of this amount the sum applied to extension of piers (see Report of Chief of Engineers, 1894, p. 2407) was	10,000.00

Each of the piers had been extended 40 feet; 151 feet of old east pier had been torn out and rebuilt entirely upon a deeper foundation; repairs had been made to west pier, and channel through bar had been dredged.

Amount expended and incurred in last fiscal year $2,817.11

In the last Annual Report reference was made to a considerable damage to east pier by the steamer *Mariposa*, which struck the end of pier in entering the harbor. Complete and satisfactory repairs were made to the pier in July, 1894, by the owners of the steamer. A few minor repairs were made to both piers in the same month.

A recommendation was submitted to the Chief of Engineers and approved to reserve $2,500 for repairs of piers and dredging, and to expend $7,500 in extension of west pier.

Proposals were invited by public advertisement dated January 21, 1895, and on February 12, 1895, bids were received and opened. The lowest bidder was Mr. John Stang, of Lorain, Ohio, and a contract was executed with him for extending west pier 72 feet in a single crib.

The grillage and wall timbers, which are secured by screw bolts in the first four courses, are put together upon ways in lengths of 36 feet and then launched; when in the water the two parts of bottom are placed end to end and the part above is built up as one crib.

At the close of the fiscal year the contractor had launched one of the grillage bottoms and had the second on the ways ready to launch.

Early in May, 1895, advices were received from Lorain that a bar had formed between the piers and at the end. A dredge plant was employed at a rate of $11 per hour for 150 hours, and at $10 per hour for 75 hours; a channel 75 feet wide and 1,500 feet long was dredged to a depth of slightly more than 18 feet. The amount dredged was 9,405 cubic yards, which made the cost per yard about 25.4 cents. This cost is much too high, and yet the small amount of material to be dredged at an isolated place where commercial interests were suffering from every day's delay made the hiring of a dredge already in the harbor a necessity.

A survey of the channel made in June, 1895, shows that it is in good condition.

The extension of west pier will be completed in August.

In the last annual report mention was made of the probable establishment of extensive works for manufacture of steel. The works are now in operation and will doubtless have the effect of largely increasing freights by water as well as by rail to Lorain.

Black River is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fourth order at the outer end of the west pier. The nearest work of defense is Fort Wayne, Mich., 80 miles distant.

Money statement.

July 1, 1894, balance unexpended		$226.93
Amount appropriated by act of August 17, 1894		10,000.00
		10,226.93
June 30, 1895, amount expended during fiscal year		2,797.61
July 1, 1895, balance unexpended		7,429.32
July 1, 1895, outstanding liabilities	$19.50	
July 1, 1895, amount covered by uncompleted contracts	6,390.86	
		6,410.36
July 1, 1895, balance available		1,018.96
Amount (estimated) required for completion of existing project		38,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		38,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of proposals for extension of pier, improving harbor at mouth of Black River, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Tuesday, February 12, 1895, at 2 o'clock p. m., standard time, in accordance with advertisement dated January 21, 1895.

[Net amount available for the work, $7,500.]

No.	Name and address of bidder.	Hemlock timber.	White pine timber.	White oak timber.	Stone, per cord.	Iron plates, per pound.	Drift-bolts, per pound.	Screw bolts and washers, per pound.	Spikes, per pound.	Dredging cuts, per cubic yard.	Total.
1	Quartus A. Gillmore, Lorain, Ohio	$23.00	$33.00	$40.00	$6.00	$0.06	$0.03	$0.04	$0.04	$1.00	$6,488.26
2	John Stang, Lorain, Ohio	23.00	33.00	40.00	5.75	.04	.03	.04	.04	.95	6,390.86

Recommended that the contract be awarded to Mr. John Stang, of Lorain, Ohio, at the rates named in his proposal, his bid in the aggregate being the lowest and considered reasonable.

Abstract of contract for improving harbor at mouth of Black River, Ohio, in force during the fiscal year ending June 30, 1895.

Contract with John Stang, of Lorain, Ohio, dated March 4, 1895, for furnishing the material and doing the work required for extension of pier on the west side, a distance of 72 feet or more:

Timber and plank, per M feet, B. M.:	
Hemlock	$23.00
White pine	33.00
White oak	40.00
Stone, per cord of 128 cubic feet	5.75
Iron, per pound:	
Plates	.04
Driftbolts	.03
Spikes	.04
Screw bolts and washers	.04

Work still in progress.
Contract time for completion September 30, 1895.

COMMERCIAL STATISTICS.

The following statistics for the year 1894 relative to the commerce of the harbor at mouth of Black River, Ohio, were compiled from information furnished by the collector of customs and others.

Receipts:	Tons.
Iron ore	170,278
Lumber	13,207
Stone	1,336
Laths	75
Staves	384
Fence posts	900
Total	186,180
Shipments:	
Coal	347,835
Total freight tonnage:	
1894	534,015
1893	826,503
Decrease	292,488

Vessels.	Number.	Tonnage.
Entering	481	152,204
Departing	411	168,691

Total registered tonnage:	
1894	320,895
1893	823,953
Decrease	503,058

Draft of largest vessels using harbor 17 feet. Largest vessels do not load to full depth. No new lines of transportation have been established during the year.

M M 9.

IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

In 1825 the mouth of the Cuyahoga River was obstructed by a sand bar which formed from the east side and forced the channel westward. In time of freshets the bar would be more or less washed away, leaving the mouth of the river very broad and shallow.

To prevent further obstruction of the channel by the sand a plan of improvement was adopted to confine and direct the current over the bar by means of piers of wood ballasted with stone. The inner ends of piers were entirely within the limits of the river as defined by its banks and the low-water channel was on the west side of the west pier; the piers not only rectified the channel, but have resulted in the formation of land through natural causes, aided by business enterprise, until they are bordered on each side of the channel by valuable lots.

Changes which have resulted from this improvement of the river mouth have been of such importance, not only to navigation and commerce but to the development of the city of Cleveland, that maps showing the conditions in the early stages of the work will be of much interest and value when compared with those of the present time. Copies of maps of the mouth of the Cuyahoga River showing works completed and proposed in 1827, 1839, 1845, and 1895 are forwarded to accompany this report.

The original plan was modified and enlarged as the necessity arose until 1869, when the extension was completed. Four appropriations, 1870 to 1874, were subsequently expended in rebuilding parts of the east pier with stone, in repairs to both piers, and in dredging the channel.

The entire amount expended upon these piers and the channel represents not only the first construction but the renewal of many parts injured by storms or decayed, and also the frequent dredging of material driven into the channel by storms or brought down the river by the current in freshets and deposited at its mouth.

The total amount expended upon construction and maintenance of piers and channel, 1825 to 1875, was $346,881.61.

In 1875 Congress made an appropriation for a breakwater in 5 fathoms of water to protect the commerce of Cleveland.

The following appropriations have been made since adoption of the project:

March 3, 1875	$50,000	August 5, 1884	$100,000
August 14, 1876	50,000	August 5, 1886	93,750
August 14, 1876 (repair of pier)	8,000	August 11, 1888	100,000
June 18, 1878	100,000	September 19, 1890	75,000
March 3, 1879	100,000	July 13, 1892	100,000
June 14, 1880	125,000	August 17, 1894	50,000
March 3, 1881	200,000		
August 2, 1882	175,000	Total	1,326,750

NOTE.—About $70,000 of this amount has been expended in dredging in the harbor and channel and in maintaining old river piers. All of the appropriation of August 17, 1894, will be necessarily expended in repairs to old work, in dredging, and in making an opening in shore arm of west breakwater, so that none of it will be applicable to the extension of breakwater.

Amount expended from adoption of the project for breakwaters, 1875 to June 30, 1894	$1,268,491.94
Amount expended and incurred in last fiscal year	4,792.25

The present extent of the breakwaters is shown upon maps opposite page 2412, Report of Chief of Engineers, 1894.

The shore arm of west breakwater, 3,130 feet long, was constructed in the years 1876 to 1881, so that the oldest part is now 19 years and the newest 14 years old. The main or lake arm of west breakwater, 4,030 feet long, besides a spur 100 feet long near the harbor entrance, was built in the years 1881 to 1883, inclusive, so that the newest part is 12 years old.

The east breakwater is now 2,490.5 feet long, and was built in the years from 1888 to 1893. As before explained, the wooden part of the piers at the mouth of the river was completed twenty-six years ago.

When it is remembered that white-pine timber, situated as it is in the superstructure of these works where exposed to wet and dry weather, heat and cold, storms, etc., collisions with vessels, and to vandalism, which is a large factor in the case, becomes so much decayed in fifteen years that parts are entirely gone and most of it has so far lost its strength as to be unreliable to resist any great strain, it will be understood why it is necessary to expend a considerable sum annually in repairs to guard against the extensive injuries which would follow where a breach is made.

This is a matter of such vital importance to the improvement and preservation of Cleveland Harbor that the following paragraphs from last annual report are here repeated:

> Should the superstructure of a part of the breakwater be carried away in a storm, the crib work below water would almost surely follow, because when the cribs are exposed in heavy storms the stone is taken out by the action of the seas, and the woodwork is left with too little ballast to hold it in position.
>
> It is therefore very important that the old superstructure should be rebuilt before it is too far gone to decay to withstand the force of storms. It will be seen in the statement of expenditures that more than $4,000 of the last appropriation was expended in repairs to the breakwater. The repairs consisted almost entirely in replacing planking and deck stringers which had been broken away in the winter.

A small opening, once made, sometimes becomes the means of letting in forces which bring destruction to a large part.

A superstructure of concrete masonry is recommended as the cheapest which can be made of a reasonably permanent character, though it may probably involve the necessity of strengthening the outer walls of the cribs below water level.

In October and November, 1894, an amount of about $1,500 was expended in repairing the superstructure of west breakwater, and it is possible that two or three times as much more will be needed for indispensable repairs before the end of the ensuing fiscal year.

An expenditure of several thousand dollars is required annually for maintaining the channel by dredging.

The Cuyahoga River is the channel into which is turned nearly all of the sewage of the city of Cleveland, and the foulness of its condition during the season when the current is small, which is most of the year, can hardly be described. As a result, the west anchorage, which is so nearly inclosed as to permit no currents to pass through, has formed a settling basin for mud and impurities, to the great detriment of the harbor, and possibly to the health of the people.

For these reasons the Cleveland Chamber of Commerce passed a resolution requesting that an opening be made in the shore arm of west breakwater. The resolution and indorsements thereon are as follows:

Whereas careful investigation has proven that the opening of the breakwater at the west end will permit a current to flow from west to east of sufficient strength to remove the sewage and offal that there collect, to the detriment to the health of the city, at the same time removing danger of impure water from the same source at the crib of the city waterworks; and

Whereas such current, by unanimous consent of river men and civil engineers, would in no way impede navigation or affect the value or efficiency of Government improvements, but on the other hand would prove a positive benefit to commerce by removing the bars which form at the mouth of the Cuyahoga River and which at the present time await the use of Government appropriations to be removed: Therefore,

Resolved, That the Cleveland Chamber of Commerce hereby requests favorable action on the part of the War Department looking to the immediate removal of so much of the west end of the breakwater as may, in the opinion of the Government engineer in charge, be necessary to accomplish the end sought.

THE CLEVELAND CHAMBER OF COMMERCE,
Office of the Secretary, October 1, 1894.

SIR: I have the honor to inclose herewith attested copy of resolutions adopted by the Cleveland Chamber of Commerce at its last meeting advocating the opening of the west end of the breakwater at the harbor of Cleveland. Sincerely hoping that the action taken by this body will commend itself to your favorable consideration, I am,

Respectfully,

RYERSON RITCHIE, *Secretary.*

Gen. T. L. CASEY, U. S. A.,
Chief of Engineers.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 4, 1894.

Respectfully referred to Lieut. Col. Jared A. Smith, Corps of Engineers, for report. To be returned.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE,
Cleveland, Ohio, October 8, 1894.

Respectfully returned to the Chief of Engineers with report in separate communication herewith.

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, October 8, 1894.

GENERAL: Referring to second indorsement of this date on letter from secretary of the Cleveland Chamber of Commerce (Office of Chief of Engineers, 8480, October 3, 1894), I have to submit the following report:

Since I have been in charge of the improvement of Cleveland Harbor I have had many occasions to observe the exceedingly unwholesome condition of the water in the Cuyahoga River and in the anchorage behind the west breakwater.

When there have been heavy rains or melting snows the current in the river is rapid and the water is very muddy. At such times the part of the current which has spread to westward after passing beyond the river piers is stopped by the breakwater and diverted into the basin, so that there is a very slight movement like an eddy throughout the anchorage, which thus becomes a settling basin for the muddy and filthy water. During the summer the same principle obtains, but while there is little mud there is such a vast amount of sewage that the odors are sickening.

At nearly all times there are currents more or less marked along the shore of the lake from west to east or east to west, according to the direction of the wind. When the winds are easterly the discharge into the lake is through the opening between the breakwaters, and the currents carry this foul water directly past the place where the city has a crib at the outer end of the water conduit, which takes the supply from the lake.

When there is a sufficient opening in the shore arm of west breakwater, the current from east to west would pass through the harbor and the discharge into the lake would be so far inside the water crib that danger of contamination would be very greatly reduced.

When the winds are from westward, which is the greater part of the time, the opening suggested would permit a slight current through the harbor parallel with the shore, and a large part of the mud and filth would be carried to a greater or less distance beyond and would settle in the lake, where its effects would be inappreciable.

As a measure of city sanitation I regard the opening in west arm of breakwater as being of great importance. It is my opinion that the currents passing through the harbor would ordinarily be of small velocity, save perhaps at times through the opening itself, and they would therefore not be likely to remove bars and other accumulations previously deposited, nor would they prevent formation of bars at the mouth of the river, but the deposits in the harbor would be less rapid, and, as a result, there would be a saving of expense in maintenance of the anchorage by dredging, besides the very great benefit of purer water in the basin.

As the bad effects of collecting the filth and mud in the west anchorage basin and along the adjacent shore are due to the fact that the currents are shut off by the breakwater, it seems proper that a suitable opening should be made as a part of the harbor improvement.

I therefore recommend that an opening of about 200 feet in length be made in the shore arm of the west breakwater, the outer edge of opening to be at the outer end of the cribs, of 24 feet in width and 1,350 feet from the northwest angle of the breakwater. Should it be found desirable later, this opening may be continued farther toward the shore.

At present there is no shipping on the shore front behind the breakwater. Should piers be built at any future time, those near the opening can easily be protected from seas by a short arm of breakwater extending westward from the outer edge of opening and parallel to the shore.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 10, 1894.

Respectfully returned to Lieutenant-Colonel Smith with request for statement of the estimated cost of making the opening recommended, also what funds are available for the purpose.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Fourth indorsement.]

U. S. ENGINEER OFFICE,
Cleveland, Ohio, October 16, 1894.

Respectfully returned to the Chief of Engineers.

I have no means of making a definite estimate on that class of work owing to the fact that there are no records in this office to show the cost of tearing out the substructure.

The firm of Messrs. L. P. & J. A. Smith, contractors, submitted an estimate to me to-day in round numbers, $10,000, for removing 200 feet of cribs and superstructure and putting bulkheads in where cut through. I consider the estimate extravagant, and am sure that it may be done for less than half that amount.

With this explanation I submit an estimate for removal of 200 feet of superstructure and cribs in shore arm of west breakwater at $25 per foot, $5,000.

The stone from superstructure will be worth more than the cost of removal for filling space where it is needed in the breakwater.

If approved the work may be included in project for expenditure of $50,000, appropriated by act of August 17, 1894, for improving Cleveland Harbor, Ohio.

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., October 24, 1894.

COLONEL: Referring to your report of the 8th instant, on the subject of making an opening in the shore arm of the west breakwater in Cleveland Harbor, Ohio, I have to advise you that the papers in the case were submitted to the Secretary of War with indorsement, of which the following is a copy:

[Seventh indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 20, 1894.

Respectfully submitted to the Secretary of War.

This is a request from the Cleveland Chamber of Commerce that an opening be made in the west breakwater in the harbor of Cleveland, Ohio.

Inviting attention to the accompanying report of October 8 on the subject by Lieut. Col. Jared A. Smith, Corps of Engineers, in which he recommends that an opening of about 200 feet in length be made in the shore arm of the west breakwater, I recommend that the opening proposed by Colonel Smith be authorized.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

This recommendation was approved by the Secretary of War October 23, 1894.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Lieut. Col. J. A. SMITH,
Corps of Engineers.

Under date of February 15, 1895, proposals for cutting an opening 200 feet long in the shore arm of the breakwater were invited by public advertisement. Bids were received and opened March 15, 1895, the lowest being for $9,338.92, which was considered too high, and all were rejected. A recommendation was therefore submitted and approved by the Chief of Engineers to do the work by hired labor and to make the few necessary purchases in open market.

The work was commenced with a small party May 7, 1895. All the superstructure has been removed and strong bulkheads have been built in the old work at each end of the opening. The stone, amounting to 260 cords, has been transferred to the breakwater on the lake front, where it will be used to fill and strengthen the work. The stone is worth not less than $5 per cord, which virtually reduces the expense of the work to the extent of its value $1,300. The heavy riprap on west side of the four cribs in the opening has been removed and will be placed

against the breakwater where it will be of value as a protection. The opening will probably be completed in July, and it is estimated that the expense will be about $5,000.

Owing to the fact that cribs of 50 feet length were not close together the exact width of the opening is 201.33 feet. Its northerly end is 1,308 feet from the angle of the breakwater on the outside.

The appropriation of August 17, 1894, for improving this harbor was $50,000.

Of this amount the opening in the breakwater will cost, say	$5,000
There must be reserved for dredging harbor and channel in two years	5,000
For necessary repairs it is not prudent to reserve a less sum than	5,000
Contingent expenses, office, etc., at 5 per cent	2,500
Leaving for other work	32,500
Total	50,000

The expenditure of so small a sum as will be available for extending the breakwater would produce no result of practical importance. The sum would also be insufficient to construct a superstructure of concrete or other masonry over any considerable extent of the old breakwater, especially as that would involve extensive preparations as well as the reenforcement of the lake face of the old work under water.

The pier on west side of river mouth is in such bad condition that it needs to be rebuilt entire north of the bridge of the Lake Shore and Michigan Southern Railway. When this can be done the alignment should be rectified and the channel be made of uniform width. The funds now available are entirely inadequate for renewing or even properly repairing this pier.

The portion of east pier inside of the harbor line is now kept in repair by the Cleveland and Pittsburg Railway Company, operated by the Pennsylvania Railroad Company under a lease from the Secretary of War, which permits the occupancy and use of a strip 45 feet in width from the face of the pier with proviso of its being kept in good condition. The part of east pier outside of the harbor line is about 450 feet; this is a substructure of piles surmounted by superstructure of cribs, both filled with stone; the superstructure is nearly in ruins, and the substructure is in such condition that the piers can be put in good condition only by renewing the whole.

The project to rebuild the east pier as far as may be done with available funds, having a substructure of crib work filled with stone and a superstructure of concrete masonry, has therefore been approved by the Chief of Engineers. This work will be completed on or before June 30, 1896.

In April, 1895, a hydrographic survey of the channel from the breakwater to the Lake Shore and Michigan Southern Railway Bridge showed a clear mid-channel depth of 17.5 to more than 20 feet, the least depth covering but a very small place between the piers.

The harbor line on the east side of the river has been changed by the Secretary of War upon request of the superintendent of the Cleveland and Pittsburg Division of the Pennsylvania Company. The harbor line on east side is now in prolongation of the same straight line that forms the harbor line on west side until it intersects the middle line of Seneca street prolonged from which point it approaches the shore to a point on the middle line of Erie street and 1,700 feet from the end of the breakwater as proposed.

The anchorage of the harbor is ample in extent for all present or probable future necessities, but it is probable that business will soon

develop on the lake front and then the entire harbor room as planned will be needed.

It will be necessary at an early day to submit an entirely revised estimate of cost of necessary improvement of this harbor, covering, in addition to the estimated cost of completing the breakwater in accordance with present project, that of renewing the east and west piers, of reenforcing the breakwater on the face next the lake, and of rebuilding its superstructure.

The amount estimated for completion of breakwater is $494,000.

The importance of preserving and completing this harbor can hardly be overestimated, and in its present condition it is not prudent to have less than $250,000 made available by the next appropriation.

Cleveland Harbor is in the collection district of Cuyahoga, Ohio. There is a beacon on the outer end of each pier, and a beacon with flash light and fog whistle on the independent crib just inside the east end of the lake arm of the breakwater. The nearest work of defense is Fort Wayne, Mich., 110 miles distant.

Money statement.

July 1, 1894, balance unexpended	$186.90
Amount appropriated by act of August 17, 1894	50,000.00
Collection by United States attorney	50.00
	50,236.90
June 30, 1895, amount expended during fiscal year	3,621.97
July 1, 1895, balance unexpended	46,614.93
July 1, 1895, outstanding liabilities	1,220.28
July 1, 1895, balance available	45,394.65
Amount (estimated) required for completion of existing project	494,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals for cutting an opening in shore arm of west breakwater at Cleveland, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Friday, March 15, 1895, at 2 o'clock p. m., standard time, in accordance with advertisement dated February 15, 1895.

[Net amount available for the work, $5,000.]

No.	Name and address of bidder.	For removal of cribs, superstructure, foundation, and riprap, as specified.	For furnishing materials.				Total.
			White oak, per M feet, B. M. (4,480 feet, B. M.).	Screw bolts, per pound (2,285 pounds).	Drift-bolts, button-head, per pound (384 pounds).	Spikes, per pound (300 pounds).	
				Cents.	*Cents.*	*Cents.*	
1	L. P. & J. A. Smith Co., Cleveland, Ohio	$9,000.00	$50.00	4	3	4	* $9,338.92
2	John Stang, Lorain, Ohio	9,500.00	50.00	4	5	5	9,849.60
3	Thomas E. Wilson, Cleveland, Ohio	13,000.00	40.00	4	3	4	13,294.12

*Lowest received; recommended that all the bids be rejected.

MAP
OF A PART OF
CLEVELAND HARBOR, OHIO,
SHOWING ENTRANCE TO
CUYAHOGA RIVER.

U.S. Engineer Office,
Cleveland, Ohio.
To accompany annual report for fiscal year ending June 30, 1895.

Jacob C. Smith
Lieut-Col. Corps of Engineers, U.S. Army.

LAKE ERIE

A WEST BREAKWATER

EAST BREAKWATER

LIGHT-HOUSE & FOG SIGNAL

WEST PIER LIGHT

EAST PIER LIGHT

TRUE MERIDIAN

NOTE
Soundings are in feet and tenths and are referred to mean lake level, 1860-'75.
Soundings taken April, 13, & 15, 1895.

SCALE OF FEET
100 0 100 200 300 400 500 600 700 800 900 1000 ft.

ESTABLISHED HARBOR LINE

ESTABLISHED HARBOR LINE

Penna. Co's NEW PIER

PILE BULKHEAD

CUDDY-MULLEN CO.'S NEW COAL PIER

SLIP

U.S. CUSTOM HOUSE, RIVER OFFICE.

U.S. LIFE SAVING STA.

U.S. ENGINEER'S OFFICE

MOUTH OF RIVER IN 1827

ENTRANCE TO OLD RIVER BED

CUYAHOGA RIVER

FRONT STREET

EAST RIVER STREET

SPRING ST.

Eng 54 1

MAP

of the Mouth of

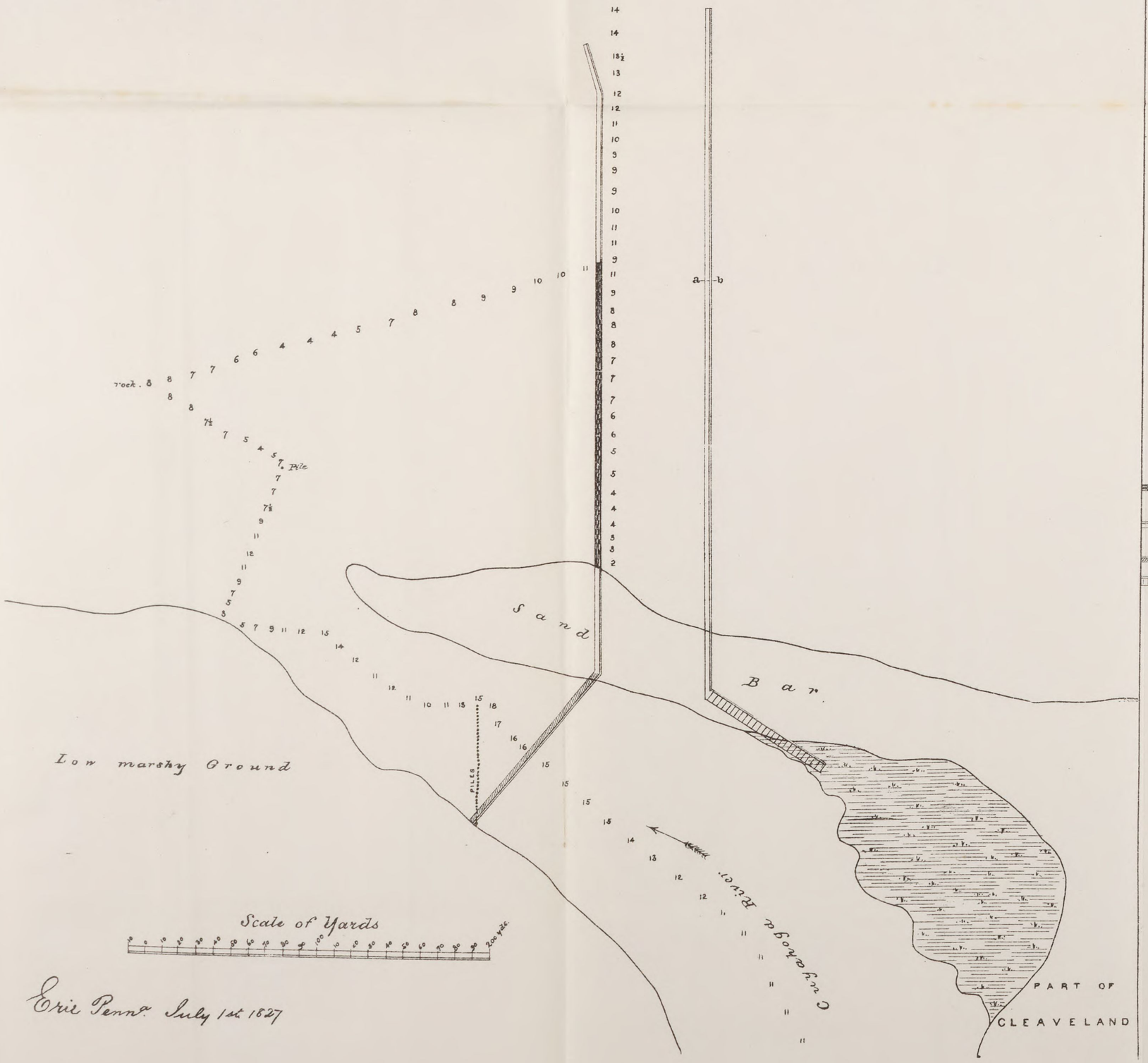
CUYAHOGA RIVER

OHIO

Exhibiting a PLAN for removing the obstructions at its entrance

by

T. W. Maurice
Capt. of Engrs.



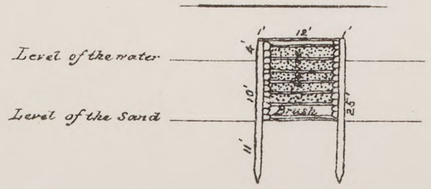
References

- Pier executed in 1826.
- Proposed extension of ditto and proposed additional Pier
- Proposed Dam.
- Revetment of timber

Note: Soundings are in feet

Remark: Water nearly two feet higher than usual.

Section of Pier at ab.



U.S. Engineer Office,
Cleveland, Ohio.
To accompany annual report for fiscal year ending June 30, 1895.

Jared A. Smith
Lieut-Col. Corps of Engineers, U.S. Army.

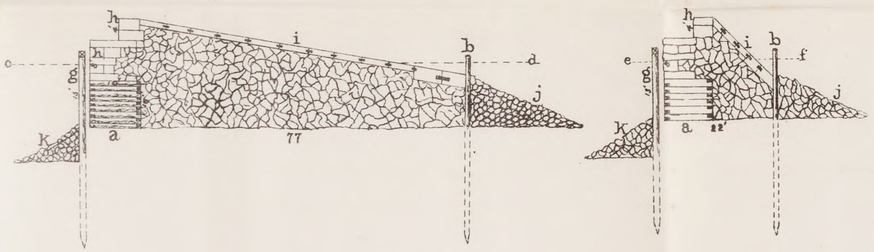
Eng 54 1

LAKE

Transverse Sections of East Pier, Cleveland Harbor on the lines c.d. & e.f.

showing the pier completed on the present plan, At e.f it is actually now completed.

Scale of feet.



References.

a.a. Old crib work forming foundation to new stone piers. Upper Six feet removed
b.b. New piles well driven and Sustaining Stone thrown in to form new pier
g.g Old piles left with their caps to protect new work until Thoroughly Set.
h.h. Facing of Masonry Blocks of dressed stone laid in cement with Cramps and vertical dowels.
i.i. Coping laid in cement with cramps and horizontal dowels.
j.j. Stone thrown in to sustain the piles.
k.k. Inside of Harbor channel: Stone to prevent the undermining of the work.

U.S Engineer Office,
Cleveland, Ohio.
To accompany annual report for
fiscal year ending June 30, 1895.

Jared A Smith

Lieut-Col. Corps of Engineers, U.S Army.

MAP
of
CLEVELAND HARBOR.

Scale of feet.

1839.

by Col. James Kearney
Corps of Topogl. Engineers.

Transverse Section on line c.d.
Showing the present condition of the work at that point.

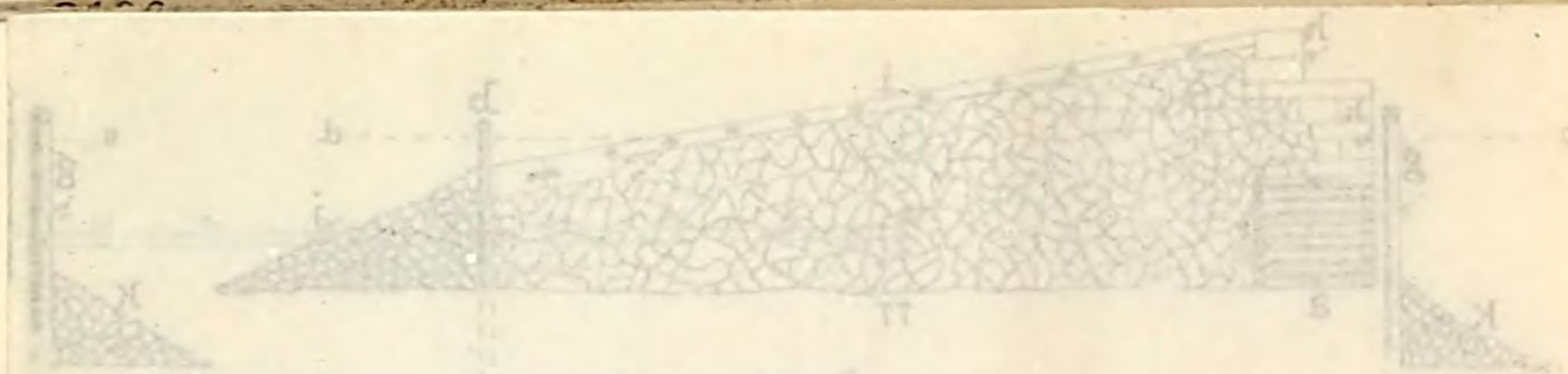
Scale of feet.

References.

a. Old crib work, upper six feet to be removed and replaced by masonry
b. Stone thrown and settling additional quantity to increase the weight at S which it to be removed to the broken line p.q.
p.q. Line of the present crest of the work (coping) when complete.
e. Inside of Harbor: Stone heretofore thrown in to prevent the undermining of the cribs and to sustain the piles.

The full lines show the condition of the works above water in the year 1839. The broken lines show the line of crib-work proposed by the Board of Engineers in 1854.

Eng 54 1



Lake Erie

U.S. Engineer Office,
Cleveland, Ohio.
To accompany annual report for
fiscal year ending June 30, 1895.

Jared A. Smith
Lieut.-Col. Corps of Engineers, U.S. Army.

Scale of feet.
500 400 300 200 100 0 500 1000 1500 2000 2500 ft.

N

Lake Erie

Cuyahoga River

Sandy Beach
3 or 4 feet high.

Old bed 40 years ago.
mouth when first opened

Ship Canal

Low, wet, & marshy.

Low dry ground

15 ft. water

Old bed of Cuyahoga River.

Low, wet & marshy

Town Sandy Beach.

mouth when commenced.

Old bed of River when the mouth was about one mile west from its present

Old bed of River

Cuyahoga River

Office of Pub works
Cleveland Harbor Ohio
29. Sept. 1845.

(Signed) L. B. W. Stockton
U. S. Agent &c

-Ohio City-

N

Offices &c.

Stone Yard

B.S. Shop

Scale of feet.
0 50 100 150 200 ft.

City of Cleveland

Eng 54 1

COMMERCIAL STATISTICS.

The following statistics for the year 1894 relative to the commerce of the harbor at Cleveland, Ohio, were compiled from information furnished by the collector of customs and others:

Shipments.	Tons.	Receipts.	Tons.
Coal	1,117,894	Iron ore	2,015,828
Iron	61,809	Steel ingots	933
Oil	6,500	Copper	1,260
Nails	35,494	Miscellaneous	657,469
Miscellaneous	146,617		
Total	1,368,314	Total	2,675,490

Total freight tonnage:	
1894	4,043,804
1893	4,189,922
Decrease	146,118

Vessels.	Number.	Tonnage.
Entering	3,384	2,264,929
Departing	3,345	2,287,073
Built	11	10,241.94

Total registered tonnage for 1894 (vessels entering and departing)	4,552,002
Total registered tonnage for 1893 (vessels entering and departing)	4,032,686
Increase	519,316

Draft of largest vessels using harbor, 17½ feet. Largest vessels do not load to full depth.

New lines of transportation were established as follows, viz: The Marine Bank Company, the L. P. & J. A. Smith Company, the Cleveland Tug Company, the Standard Contracting Company, and the Minch Transit Company.

M M 10.

IMPROVEMENT OF FAIRPORT HARBOR, OHIO.

The harbor of Fairport is near the mouth of the Grand River, Ohio, which is navigable for some distance from the lake.

In 1825 the sand bar across the mouth was so hard and dry in the summer that teams could be driven across. In that year a plan was adopted, for improving the harbor by the method of parallel piers to confine and protect the channel. The plans have been modified and extended from time to time until 1890, when the latest project was adopted, providing for extending the parallel piers to a depth of 18 feet in the lake. The widths between piers were planned to be 200 feet, but owing to imperfections in construction and alignment and the movement caused by storms, the general width between piers is but 185 feet, though in a few places it is about 195 feet.

The project and estimate of cost, as modified in 1892, is as follows:

For two parallel piers, each 1,060 feet long, 2,120 linear feet, at $100 per foot	$212,000

It should be noticed that the estimate is for original cost only of the construction of the piers, and that all the necessary expenses for maintaining the channel depths and the piers are additional.

It is not practicable at any time to make a definite estimate for dredging and repairs which shall fully and finally complete all that may be needed. They are more or less necessities of each year, and when imperatively required must be completed as far as practicable with available funds, leaving the balance not thus required to carry on the project of improvement.

The amount of twenty-five appropriations, from 1825 to 1890, was	$320,873.53
Entire amount expended previous to July 1, 1892, when present project was adopted	319,503.08
Available July 1, 1892	1,370.45
Appropriated by act of July 13, 1892	35,000.00
Appropriated by act of August 17, 1894	20,000.00
Total since adoption of project	56,370.45
Expended July 1, 1892, to June 30, 1894	29,553.90

An examination of the piers made October 18, 1894, when the stage of water was very low, showed that a section of the west pier, nearly 138 feet long and originally 20 feet wide, was in such bad condition, both above and below water, as to make its entire renewal imperatively necessary.

The piers were originally placed upon the natural bottom of the lake and the later deepening of the channel had caused the piers to settle and tip inward at that place. The upper part was much decayed and the cribs were in bad condition.

The recommendation to remove and rebuild this part of the pier was approved by the Chief of Engineers. Proposals for doing the work were invited by public advertisement dated February 1, 1895, and the bids were opened March 1, 1895. The lowest bidder was Mr. James B. Donnelly, of Buffalo, N. Y., with whom a contract was made to do the work for the sum of $10,921.

The stone and iron in the old work was of sufficient value in building and filling the new cribs to make compensation for tearing away the old part, so that the cost of the entire repair was about the same as would have been paid for an equal extent of new pier.

Work under the contract was commenced April 15, 1895, and the new part of the pier was completed June 11, 1895.

The entire length was constructed and placed in a single crib; the grillage was built and launched in four sections, which were placed end to end and built up continuously into one crib. The crib rests upon the bottom in a trench excavated to a depth of 20 feet. The sand bottom of the lake is several feet above the base of crib on its west side; on the east or channel side the crib is constructed with bottom grillage timbers, extending outside a distance of 6 feet. The projecting timbers are covered with plank, to prevent the wash which often undermines such structures when upon a sandy or soft bottom.

The part renewed has a width of 20 feet and is 26 feet high, the superstructure being 6 feet above mean water level. Eighteen courses of timber from the bottom are of hemlock and eight courses are of white pine. Corner pieces are of pine.

As this crib contains some new features in construction, especially the apron at bottom on channel side, a drawing showing its design is forwarded to accompany this report. The same design, with apron on both sides, was shown in Annual Report of Chief of Engineers, 1894, opposite page 2424.

Fairport Harbor is peculiarly subject to the formation of sand bars, there being no place in this district where so frequent dredging is required to maintain the channel depths.

It is a noticeable feature along this shore of Lake Erie that the sand bottom forms in ridges; when not modified by local conditions these ridges are parallel to the shore, but vary in location and amount from time to time according to the direction and force of storms. At the mouths of the streams which form most of the lake harbors the bars are not entirely due to the movement of material on the bottom of the lake, but their formation is largely aided by the mud and sand which are carried or forced along by the current at times of freshets.

At Fairport Harbor, as well as at several others, much sand is blown from the beach, principally on the west side, and is carried over the piers into the channel, where it remains until the current is sufficiently strong to push it along to the end of the piers where the bar is formed. In 1893 a bar was formed in the lake entirely outside the limits to which the piers are to be extended and it was subsequently removed by dredging. This bar was evidently due to the effect of the seas, aided by reactions caused by the piers, because the bar was crescent-shaped with convex side to the lake and it did not extend to any distance on either side of the prolongation of the piers. (See map opposite p. 2418, Report of Chief of Engineers, 1894.)

The pier on the west side of the river mouth is now about 2,000 feet long and the shore line on that side has moved outward about 1,250 feet by the accumulation of sand. The contours of depth are also bent outward, though to a less extent than the shore line.

These facts present a question for careful study regarding the economy of improving this harbor by the method of further great extensions of the parallel piers.

In October, 1894, a bar had formed so that it became necessary to dredge in order to permit heavily loaded vessels to enter. The only practicable method of doing the work was by hiring a dredge and scows by the day. Dredging was commenced October 26, 1894, and continued when weather permitted until November 20, 1894, the total amount removed being but about 2,661 cubic yards. In the latter part of April and early part of May, 1895, the bar had again formed and the channel was dredged to a depth of 18 feet by the removal of about 4,380 cubic yards of sand. Surveys of the bar were made in October, 1894, and April, 1895, to determine the amount of dredging required.

Under these conditions it has not seemed advisable to expend the balance of the appropriation in extending the piers but rather to retain it as a fund for maintenance of channel and piers until further appropriations may be available.

In August, 1894, a claim was made on behalf of the American Transportation Company, of Painesville, Ohio, for an amount which had been forfeited under the terms of a contract for dredging in 1890 and 1891. As the claim has been brought to the attention of Congress the correspondence with this office is given in order that the conditions may be understood:

PAINESVILLE, Ohio, *August 18, 1894.*

SIR: I take the liberty of asking your attention to the claim of the American Transportation Company for dredging done at Fairport Harbor, Ohio, in 1891.

The claim is for $5,434.18, with interest from July 1, 1891.

As will appear from accompanying documents, a special act was required in order to secure payment. A bill for that purpose, which I inclose a copy of, was introduced in the House in the Fifty-second Congress, and reported upon favorably by the Committee on Claims.

I also inclose copies of bills introduced in House and Senate of the Fifty-third Congress. The House bill was favorably reported by Committee on Claims of the House.

The Senate bill passed the Senate the latter part of July, and the same passed the House August 1, 1894. Will you kindly advise what further action, if any, is necessary to secure payment of this claim?

Respectfully, yours,

J. B. BURROWS,
Attorney for American Transportation Company.

Hon. J. B. DOE,
Assistant Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
August 22, 1894.

Respectfully referred to Lieut. Col. Jared A. Smith, Corps of Engineers, for detailed report of the balance remaining unpaid to the American Transportation Company under a contract between that company and the United States, for dredging done at Fairport Harbor, Ohio, which contract is referred to in private act No. 93, approved August 2, 1894, a copy of which is herewith.

H. M. ADAMS,
Acting Chief of Engineers.

[Third indorsement.]

U. S. ENGINEER OFFICE,
Cleveland, Ohio, September 13, 1894.

Respectfully returned to the Chief of Engineers.

It appears from the records in this office that under date of November 28, 1890, the American Transportation Company, of Painesville, Ohio, entered into contract with Maj. L. Cooper Overman, in behalf of the United States of America, to furnish all the labor, materials, and machinery necessary, and to do the work of dredging 65,000 cubic yards, more or less, from the channel between the piers and over the bar outside at Fairport Harbor. Dredging was to be commenced on or before November 25, 1890, and to be completed on or before May 30, 1891. The contract was made upon the regular forms (No. 19) furnished by the Engineer Department of the Army, with specifications for the work appended as part of the contract. The contract was approved by the Chief of Engineers December 13, 1890.

Under date of May 15, 1891, the company asked an extension from May 30 to July 30, 1891, in time for completion of contract. The extension was granted May 23, 1891. Various letters from this office called attention of the company to the fact that progress was not satisfactory, and the company was informed that another dredge was necessary in order to do the work promptly. Under date of July 31, 1891, the manager of the company was informed that the contract had expired and that no further work could be done under it.

The expressed conditions in the contract were that in case of failure to complete the contract as specified and agreed upon, all sums due and percentage retained should be thereby forfeited to the United States.

The monthly reports indicate that a total of 50,902 cubic yards of material was dredged, and that the dredge was employed removing logs ten hours and thirty minutes, which Major Overman estimated as equivalent to 390 cubic yards of material, which, at 17½ cents per yard, amounts to $8,976.10.

Payments were made by Major Overman, as follows:

1890, December, voucher 1	$1,148.65
1891, April, voucher 3	2,439.99
Total paid	3,588.64
Balance unpaid	5,387.46

From this should be deducted the expenses during the period of extension in the same manner as would have beer done had the contract been completed. This expense is as follows:

June:	
Inspector	$110.00
Subinspector	52.00
Boatman with boat	1.50
July:	
Inspector	110.00
Subinspector	54.00
Total	327.50

It should be added that the forfeitures were incurred under the provisions of the contract, and it should also be added that the work was not carried on to the satisfaction of the officer in charge of the improvement.

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

In the last annual report mention was made of the fact that the river and harbor act of August 11, 1888, authorized the Secretary of War to grant to owners of dock property abutting the river permission to use the Government pier under such regulations as the Secretary of War might determine; also that in accordance with the terms of this act the Consumers' Forwarding and Storage Company had received a license to occupy and use the pier at an annual rental of $2,000. This amount was paid for a single year and has since been refused, although the pier has been constantly occupied and used.

The matter has been twice referred to the Department of Justice with request for such action as the nature of the case demands. (See pp. 2417 and 2418, Report of Chief of Engineers, 1894.) No action has thus far been taken. The company has taken possession of the pier, and has removed and rebuilt certain portions of it without in any way consulting or informing the officer in charge of the improvement, so that his first knowledge of the fact was by personal observation after the work was completed.

If such action be legal, it would seem that it should be so decided by the court, in order that the officer in charge of the improvement may be relieved from the necessity for any further action or responsibility in the matter.

The company which has thus taken the pier is understood to have practically the same interest and to be managed by the same agent as the American Transportation Company, which brought claim for money forfeited by nonfulfillment of contract for dredging.

In December, 1894, the Painesville Board of Trade made application for the establishment of harbor lines at Fairport, Ohio.

After very full inquiries on the subject, and a personal examination accompanied by the secretary of the board of trade of Painesville, and others, a report was submitted with a map showing the lines recommended. These were approved as harbor lines by the Secretary of War, January 11, 1895. A copy of the map was forwarded to the board of trade of Painesville, and was furnished to other interested parties.

Early in June, 1895, a complaint made by Mr. Horace Alvord, of Painesville, stating that a dock company was engaged in placing permanent obstructions in the waters of Grand River beyond dock line, was referred to this office for report.

An examination showed that the facts were as stated, and a report was submitted accordingly. The obstruction consisted of a wharf upon piles which extended about 60 feet into the river beyond the harbor line.

In compliance with requirements of section 11 of the river and harbor act of September 19, 1890, information of the fact was given to the United States attorney for this district on June 13, 1895.

A map of Fairport Harbor showing the harbor lines established January 11, 1895, and the modification established June 20, 1895, is forwarded to accompany this report.

While there is practically but one railroad terminating at Fairport Harbor, and the wharf improvements for transfer of coal and ore appear to be under one general management, yet there are several corporations or companies with interests so interwoven that it is difficult to locate their limitations or responsibility.

It is interesting to note that it is one of these companies which has refused to pay the rental of a pier which it leased and occupies, and of which it has rebuilt a portion. Another of the companies has brought a claim against the United States for money forfeited by its failure to comply with the terms of a contract, and still another has constructed

a wharf beyond the harbor line as established at that time. The map which was brought to this office with a proposition for modification of the harbor line so that it should pass outside of the wharf which had been illegally constructed, was a blue print made in this office and given out for the special purpose of informing the companies operating at Fairport of the location of the harbor lines which have been established.

The expenditures on this improvement in the last fiscal year are divided as follows:

Renewing nearly 138 feet of pier	$10,921.00
Superintendence	225.00
Dredging and superintendence, October and November, 1894	362.08
Dredging, April and May, 1895	581.25
Repair of pier, October, 1894	6.91
Survey	205.70
Office, and all other contingent expenses	1,528.51
Balance available	12,986.07

The channel between the piers generally has a good depth of water. The latest soundings between piers were taken in June, 1893, when the depths exceeded 20 feet. The amount of ore and coal transferred at this harbor is very large, the tonnage in that respect being the third in size upon Lake Erie.

Fairport Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the third order on the shore and a beacon on the east pier.

Money statement.

July 1, 1894, balance unexpended	$6,816.52
Amount appropriated by act of August 17, 1894	20,000 00
	26,816.52
June 30, 1895, amount expended during fiscal year	13,784.62
July 1, 1895, balance unexpended	13,031.90
July 1, 1895, outstanding liabilities	45.83
July 1, 1895, balance available	12,986.07
Amount (estimated) required for completion of existing project	190,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	100,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals for removing and rebuilding a part of west pier at Fairport Harbor, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Friday, March 1, 1895, at 2 o'clock p. m., standard time, in accordance with advertisement dated February 1, 1895.

[Net amount available for the work, $15,000.]

No.	Name and address of bidder.	For furnishing all materials and doing all work required, in accordance with specifications.	Remarks.
1	C. E. Mitchell & Co., Ludington, Mich	$14,947.00	
2	L. P. & J. A. Smith Co., Cleveland, Ohio	12,000.00	
3	R. J. Cram, Detroit, Mich	17,800.00	
4	James B. Donnelly, Buffalo, N. Y	10,921.00	Lowest bid received.
5	Joseph J. Churchyard, Buffalo, N. Y	13,369.35	Slightly informal.
6	John Stang, Lorain, Ohio	14,800.00	

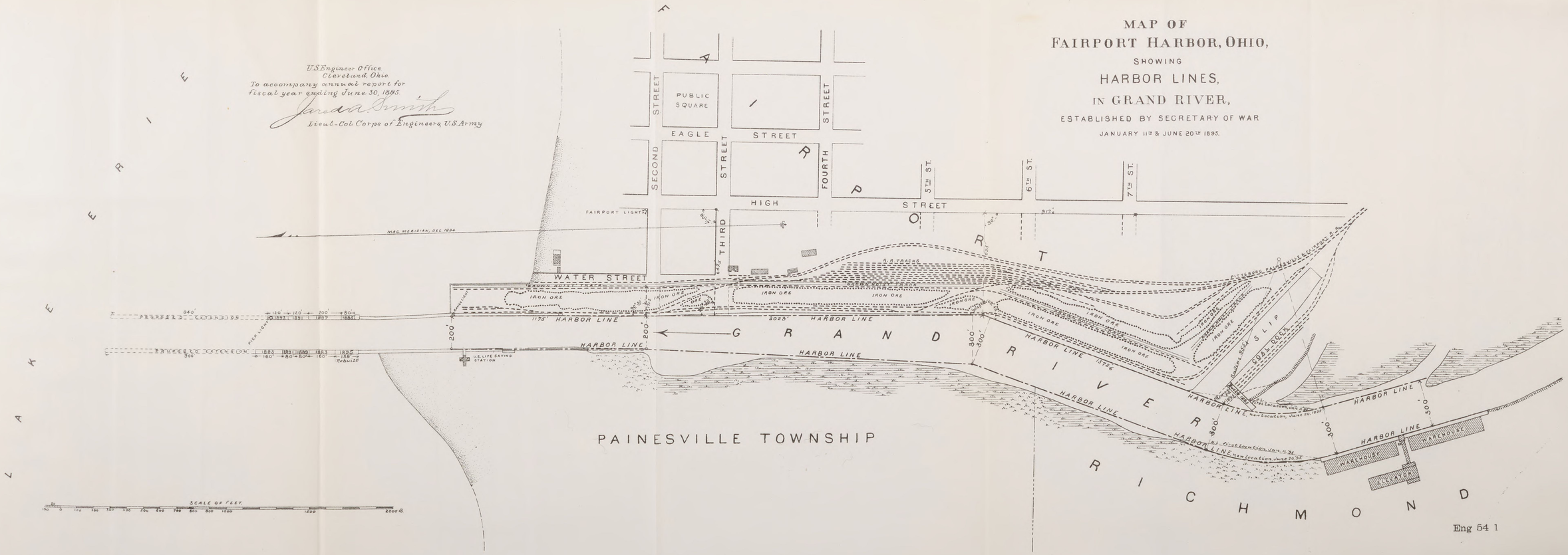
Recommended that the contract be awarded to Mr. James B. Donnelly, of Buffalo, N. Y., his bid being the lowest, and he responsible.

MAP OF FAIRPORT HARBOR, OHIO, SHOWING HARBOR LINES, IN GRAND RIVER,

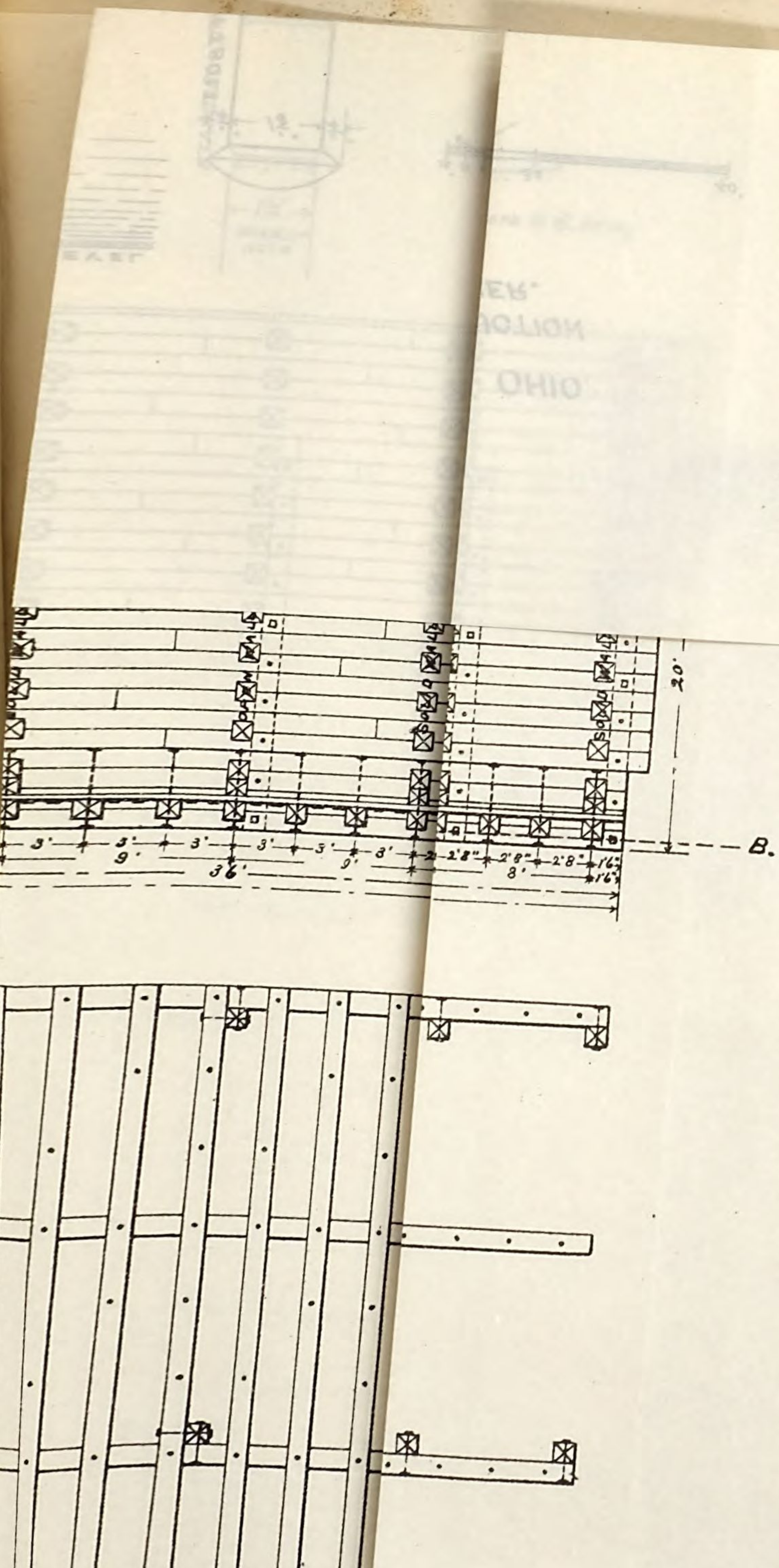
ESTABLISHED BY SECRETARY OF WAR JANUARY 11TH & JUNE 20TH 1895.

U.S. Engineer Office
Cleveland, Ohio
To accompany annual report for
fiscal year ending June 30, 1895.

Jared A. Smith
Lieut.-Col. Corps of Engineers U.S. Army



Eng 54 1

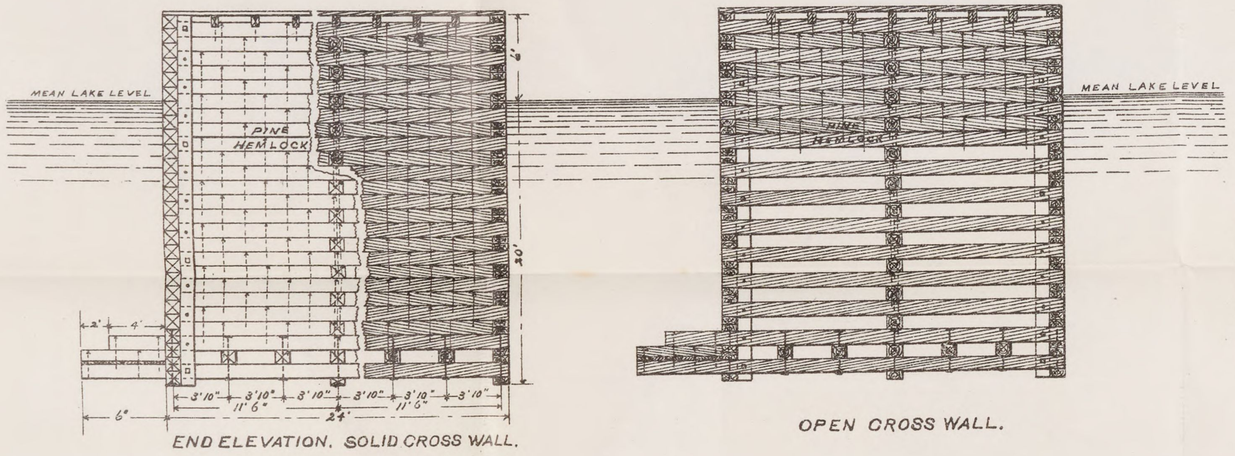


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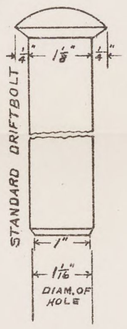
FAIRPORT HARBOR, OHIO.

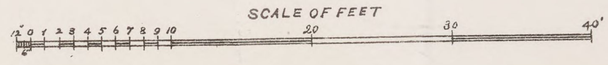
DESIGN FOR RECONSTRUCTION OF PART OF WEST PIER.



END ELEVATION. SOLID CROSS WALL.

OPEN CROSS WALL.

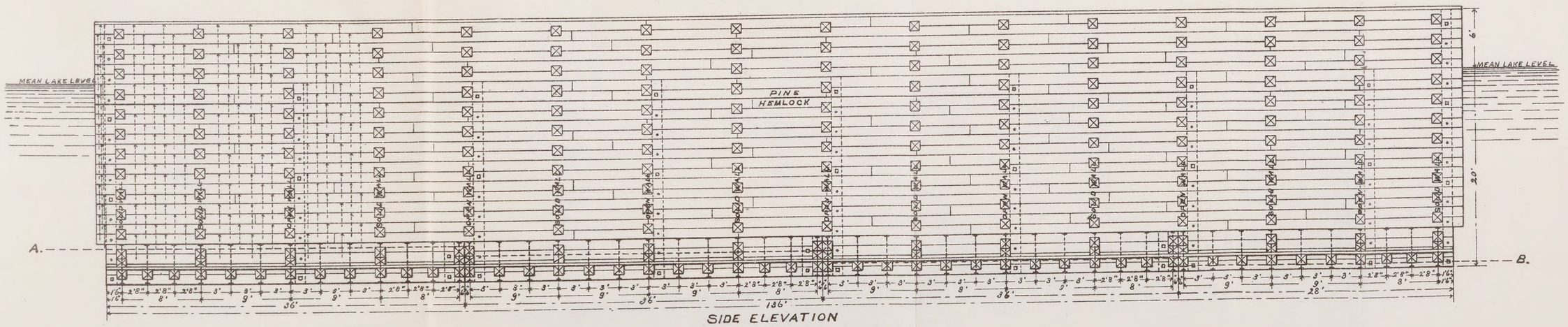




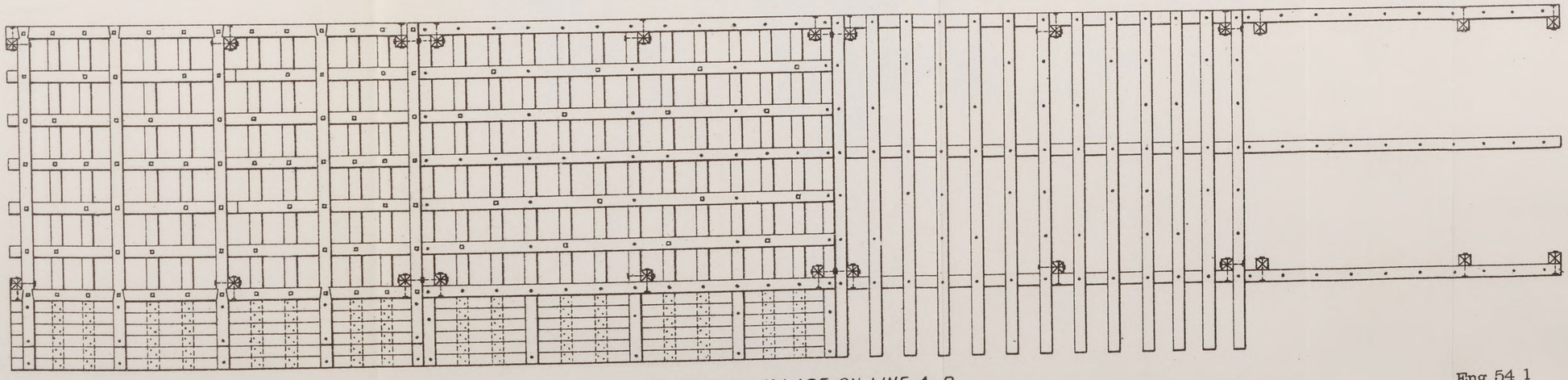
U. S. Engineer Office
Cleveland, Ohio.
To accompany Annual Report for
Year ending June 30, 1895.

Jared A. Smith

Lieut. Col. Corps of Engineers U. S. Army

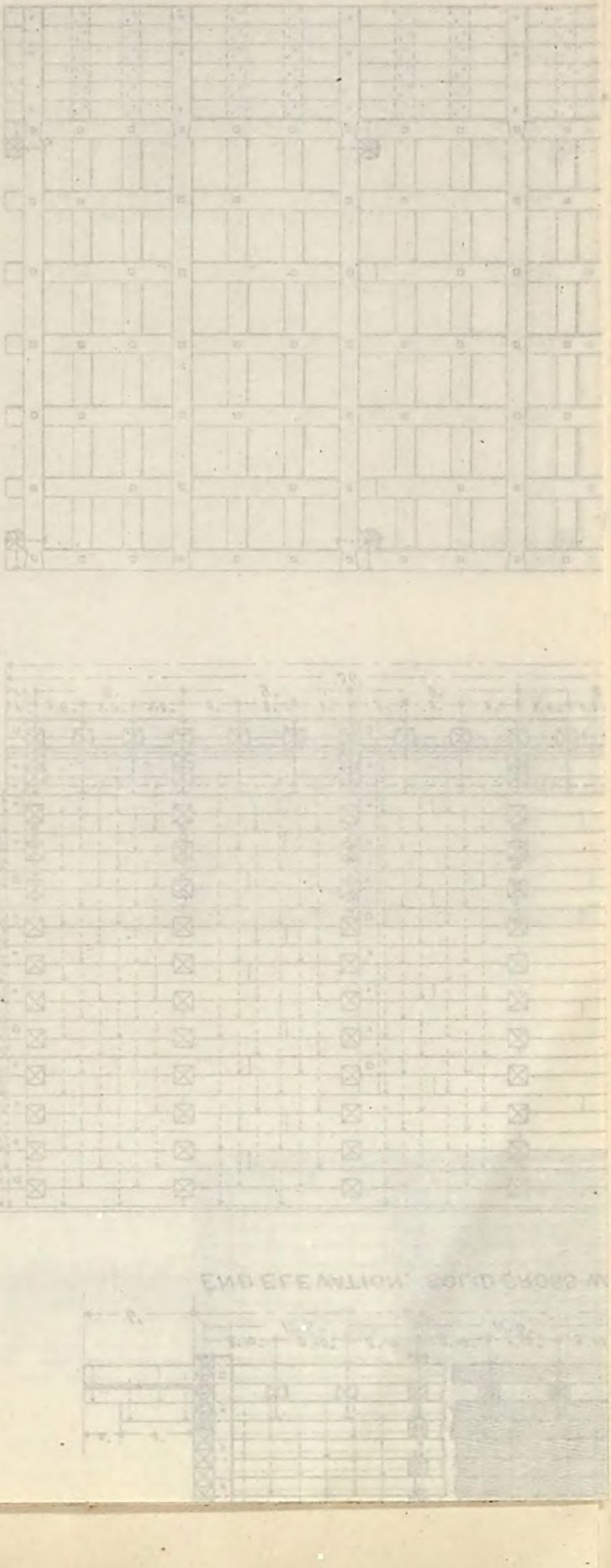


SIDE ELEVATION



PLAN OF GRILLAGE ON LINE A.-B.

Eng 54 1



Abstract of contract for improving harbor at Fairport, Ohio, in force during the fiscal year ending June 30, 1895.

Contract with James B. Donnelly, of Buffalo N. Y., dated March 12, 1895, for furnishing all materials and doing all the work required in removing and rebuilding part of west pier.

Contract completed and closed.

COMMERCIAL STATISTICS.

The following statistics for the year 1894, relative to the commerce of the harbor at Fairport, Ohio, were compiled from information furnished by the collector of customs and others.

Receipts.	Tons.	Shipments.	Tons.
Ore	1,093,368	Coal	290,787
Corn	163,676	Merchandise	71,027
Wheat	174,356		
		Total	361,814
Total	1,431,400		

Total freight tonnage:

1894	1,793,214
1893	1,215,613
Increase	577,601

Vessels.	Number.	Tonnage.
Entering	530	794,613
Departing	550	757,539

Total registered tonnage:

1894	1,552,152
1893	1,127,610
Increase	424,542

Draft of largest vessels using harbor 16 feet. Largest vessels do not load to full depth. No new vessel lines established during the year.

M M 11.

IMPROVEMENT OF ASHTABULA HARBOR, OHIO.

In 1826 the natural conditions of Ashtabula River afforded but 2 feet depth of water over the bar at the mouth, and the rock bottom was but 9 feet below the surface of the lake.

A plan was adopted to improve the channel by confining it between parallel piers of timberwork filled with stone. The plans have been modified and extended from time to time as the necessities of commerce required, and have included the removal of material overlying the rock and also of the shaly rock itself to a depth of 17 feet. A large amount has been necessarily expended in repairing the old work, because even the best timber above water becomes almost entirely decayed in fifteen years.

The latest project, proposed in 1890 and amended and approved in 1891, consists in widening the channel by placing the east pier 45 feet farther eastward, and deepening the channel by extending the piers to a depth of 22 feet in the lake and removing the rock to a depth of 20 feet.

Previous to commencement of work on the present project thirty appropriations had been made for improving this harbor, from 1826 to 1890, amounting to $467,401.21

Expenditures and liabilities to June 30, 1892	$458,734.46
Balance available July 1, 1892, for present project	8,666.75
Appropriated by act of July 13, 1892	70,000.00
Appropriated by act of August 17, 1894	75,000.00

The last-named act was for continuing the improvement, "including a survey to determine what improvement thereof should be made with a view to making it a harbor of refuge and enlarging its capacity for the purposes of commerce."

Amount expended upon present project to June 30, 1894, including liabilities	$72,390.30

This had resulted in widening the channel outside of the slip of the Lake Shore and Michigan Southern Railway to 213 feet by the removal and rebuilding entirely new of 242 linear feet of east pier and its extension 240 feet farther, making 480 feet of new pier on east side, also in the extension of the west pier 240 feet.

At the close of the last fiscal year work was in progress by hired labor removing superstructure from a part of old west pier and rebuilding it with new timberwork. The stone was first removed, then the old timber and iron were taken out and replaced with new and the stone was returned.

The work of the season was completed in November, 1894. The superstructure of 522 linear feet of west pier 18 feet wide and 6 feet high, and 111 linear feet of superstructure 24 feet wide and 7 feet high were entirely removed and rebuilt with new timber. All the stone and part of the iron were used in rebuilding.

The actual cost of the repair is given in the following table:

Articles.	Quantity.	Price.	Cost.
White pine, feet, B. M.	40,069	$20.00	$801.38
Do, do	227,198	22.00	4,998.36
Do, do	34	25.00	.85
Do, do	937	26.00	24.37
White oak, do	56	30.00	1.68
Do, do	1,797	26.00	46.72
Spikes, pounds	3,200	.03 3/10	105.60
Driftbolts, do	29,462	.02 3/10	677.63
Screw bolts, do	800	.02 5/10	20.00
Cost of materials	.....	.....	6,676.59
Labor, including salary of superintendent	.....	.....	3,573.51
Ropes, tools, etc	.....	.....	95.37
Hire of tools and scow	.....	.....	267.00
Total cost	.....	.....	10,612.47

This work included tearing down the old superstructure, removing and replacing 732½ cords of stone, and using a considerable quantity of the old iron, all of which appears in the cost of labor. Nearly all the stone had to be handled twice and some of it three times; it consisted of very small pieces closely packed into the old work, and in most places the voids were filled with sand and dirt, so that the handling was expensive.

Most of the purchases were made before June 30, 1894.

The amount expended on this superstructure in last fiscal year was $4,853.83.

Various small repairs were made to the old work in addition to the above.

The last contract for new piers at Ashtabula, amounting to more than $61,000, was under prices for timber and iron as follows in the work:

White pine, at $34 per M feet, B. M.
White oak, at $48 per M feet, B. M.
Spikes, at 4 cents per pound.
Driftbolts, at 3¾ cents per pound.
Screw bolts, at 5 cents per pound.

On the basis of these prices, and estimating the handling of stone at $1 per cord, which is low, and counting the tearing down of old work and using old iron at 75 cents per foot of pier length, the work by contract would have cost as follows:

White pine, 268,238 feet, B. M., at $34	$8,120.09
White oak, 1,853 feet, B. M., at $42	778.26
Spikes, 3,200 pounds, at 4 cents	128.00
Driftbolts, 29,462 pounds, 3¾ cents	1,104.82
Screw bolts, 800 pounds, at 5 cents	40.00
Handling of stone	732.50
Removing old woodwork	475.25
Superintendence by inspector	375.00
Total	11,753.92

As most of these prices were the lowest obtained for a work about six times as large, and other prices are not overestimated, it will be seen that the probable cost by contract would have exceeded the cost by hired labor by more than $1,000, or about 10 per cent. The hired labor was in strict conformity to the law which forbids the employment of any mechanic or laborer more than eight hours in any calendar day and requires a full day's pay therefor, and to the law which gives to all such employees full pay for National holidays. In these respects mechanics and laborers are usually much better paid for their labor when employed directly by the United States than they are when employed upon works carried on by contract.

In February, 1895, a survey of the bottom of the lake over the part where it is proposed to extend the piers, and to remove rock to a depth of 20 feet, was made by the very unusual method of cutting holes through the ice. The exact depth of the sand bottom was first obtained and then a steel rod was driven through the sand, which was generally but a few inches deep, to the rock beneath. The amount of rock to be removed has thus been very accurately determined. If the channel be excavated only to the inner end of the piers, the rock excavation will be 42,750 cubic yards.

Under date of February 6, 1895, proposals for excavating the channel at Ashtabula Harbor were invited by public advertisement. Copies of the specifications were also sent by mail to all parties known or supposed to have facilities for doing the work.

Bids were opened March 6, 1895, and a contract was made with Messrs. Carkin, Stickney & Cram, of Detroit, Mich., to remove the rock to a depth of 20 feet at mean lake level, at a rate of 97 cents per cubic yard for rock and at the rate of $10 per hour for dredge plant when it is required by the engineer in charge to remove overlying sand as a temporary benefit to navigation.

Commencement of work under the contract was delayed until June 17, 1895, since which time the dredge has been employed in removing sand bars, which cause inconvenience and delay to loaded vessels.

The survey required by the act of August 17, 1894, was made in October, 1894, and a report was submitted to the Chief of Engineers under date of February 28, 1895. The report recommended the con-

struction of two breakwaters, each 1,500 feet long on inner face, and two pierhead cribs, each 50 feet square, at a cost of $465,000.

This plan, if adopted, will obviate the necessity for any further extension of the piers at mouth of the river and reduce the expense of the present project by $114,000.

The report, a copy of which is appended hereto, was accompanied by a map * of the part surveyed. A reduced copy of the map is forwarded to accompany this report.

The importance of Ashtabula Harbor as a port on Lake Erie is very great, it being the greatest shipping point on the lake for iron ore and coal.

It is earnestly recommended that a large appropriation be made for this improvement during the ensuing year.

In the annual report mention was made of the fact that the steamer *C. F. Bielman* had caused considerable injury to the end of the east pier at Ashtabula Harbor. The officer in charge of the work succeeded in making arrangements by means of which complete repairs were made to the pier and all expenses were paid by the owners of the steamer.

Ashtabula Harbor is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the fifth order, varied by flashes, on the west pier. Fort Porter, N.Y., is the nearest work of defense.

Money statement.

July 1, 1894, balance unexpended	$6,836.95
Amount appropriated by act of August 17, 1894	75,000.00
	81,836.95
June 30, 1895, amount expended during fiscal year	7,777.49
July 1, 1895, balance unexpended	74,059.46
July 1, 1895, outstanding liabilities	125.00
July 1, 1895, balance available	73,934.46
Amount (estimated) required for completion of existing project	180,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	180,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals for excavating channel at Ashtabula Harbor, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Wednesday, March 6, 1895, at 2 o'clock p. m., standard time, in accordance with advertisement dated February 6, 1895.

[Net amount available for the work, $69,950.]

No.	Name and address of bidder.	For excavating rock, per cubic yard, place measurement (estimated quantity, 28,100 cubic yards).	For furnishing dredge, tug, and scows, for removing shoals, per hour (estimated time required, 160 hours).	Total.
1	R. J. Cram, Detroit, Mich	$1.78	$10.00	$51,698
2	L. P. & J. A. Smith Co., Cleveland, Ohio	1.79	11.00	52,059
3	Edward J. Hingston, Buffalo, N. Y	1.34	9.50	39,174
4	John Stang, Lorain, Ohio	1.90	12.00	55,310
5	Carkin, Stickney & Cram, Detroit, Mich	.97	10.00	*28,857
6	James Rooney, Toledo, Ohio	1.36	12.50	38,896

* Lowest bid received.

Recommended that the contract be awarded to Messrs. Carkin, Stickney & Cram, of Detroit, Mich., their bid being the lowest and considered very low.

*Not printed. A similar map is printed herein with Appendix M M 13.

Abstract of contract for improving harbor at Ashtabula, Ohio, in force during the fiscal year ending June 30, 1895.

Contract with Carkin, Stickney & Cram, of Detroit, Mich., dated March 15, 1895, as follows:

For excavating rock, per cubic yard, place measurement	$0.97
For furnishing dredge, tug, and scows for removing shoals, per hour	10.00
Quantity limited by amount available	69,950.00

Work still in progress. Contract time for completion, June 30, 1896.

COMMERCIAL STATISTICS.

The following statistics for the year 1894 relative to the commerce of the harbor at Ashtabula, Ohio, were compiled from information furnished by the collector of customs and others:

	Tons.
Receipts:	
Iron ore	2,225,035
Lumber	1,875
Railroad ties, etc	3,248
Fish	700
Total	2,230,858
Shipments:	
Coal	739,300
Total freight tonnage:	
1894	2,970,158
1893	2,659,960
Increase	310,198

Vessels.	Number.	Tonnage.
Entering	1,409	1,581,415
Departing	1,385	1,567,453

Total registered tonnage:	
1894	3,148,868
1893	2,666,203
Increase	482,665

Draft of largest vessels using harbor, 18 feet. Largest vessels do not load to full depth. No new lines of transportation have been established during the year.

M M 12.

IMPROVEMENT OF CONNEAUT HARBOR, OHIO.

Conneaut Harbor is formed by the Conneaut River or Creek near its mouth at junction with Lake Erie. Improvements at this place were commenced under an appropriation made by Congress March 2, 1829, and were continued at irregular intervals until 1875.

The amount appropriated and expended during the period from 1829 to 1875 was $106,629.39.

As a result, the channel, which originally had a depth of only about 2 feet, was increased to a depth of 8 or 9 feet ordinarily and to 11 feet under very favorable conditions.

The river and harbor act approved July 13, 1892, appropriated $40,000 "for relocation of channel and construction of new piers." (Scheme B of Engineer Report.)

The location was modified by an act approved February 24, 1893. (See Annual Report of Chief of Engineers, 1893, pp. 3089, 3090, and map opposite last-named page.)

Appropriations have been made for this improvement as follows:

By act of July 13, 1892	$40,000.00
By act of August 17, 1894	40,000.00
Total expended to June 30, 1894	39,979.06

Besides surveys and examinations of the bottom, there had been completed 400 linear feet of pier on the west side, nearly, in the prolongation of the old pier, to which some repairs had been made.

The amount expended and incurred in the last fiscal year has been $18,392.03

The new piers built in the previous year not being on the same alignment as the old west pier, a width of 12 feet of the end of the latter was exposed on the west side. In northwest winds the seas which chased along the face of the new work struck the exposed end of the old work with such force that, notwithstanding it had been greatly reinforced and strengthened, the entire part above water level was torn away for a length of about 20 feet.

It was desirable to preserve the old pier as long as possible, and this could only be done by protecting the end. A crib was therefore constructed on the plan of a right-angled triangle, with base of 12 feet and perpendicular of 20 feet. This crib was secured in the angle with base against old work and perpendicular against the new pier, and was then filled with stone and decked over. The end of old pier was also put in good condition. This work was commenced and completed in September, 1894, by hired labor.

The success of this small device has been remarkable. In heavy storms from the northwest the seas against the side of the pier accumulate in size and force as they move along until the part next the pier is turned away by the triangular wedge and it is thrown across the other seas in an oblique direction and breaks them up in such a manner as to greatly diminish their force. The effect of throwing the seas away from the piers is such as to suggest that similar means may be employed near the head of piers with good effect in retarding the formation of bars.

The construction of the 400 feet of pier at Conneaut in 1893 by contract was not satisfactory to the officer in charge of the improvement. The defects were not of such a nature as to justify a refusal to make payments, and yet they fell far short of the ideal which was hoped to be realized.

For the expenditure of the amount appropriated August 17, 1894, it was therefore recommended that in the construction of pier on the east side the materials be purchased by contract after advertising, and that the construction be carried on by hired labor. This recommendation was approved by the Chief of Engineers.

Under date of January 16, 1895, proposals were invited by public advertisement to furnish and deliver the timber, iron, and stone. A separate proposal was required for each kind of material.

Bids were opened February 12, 1895, and contracts were closed with the lowest bidders for each class of material at the prices shown in abstract of bids appended hereto. Most of the hemlock timber was delivered in May. It is exceptionally fine in both quality and cutting. The pine timber, also of excellent quality, was delivered June 22. Iron was delivered in May, and is remarkably good in workmanship and quality.

Mr. Q. Gillmore was employed to superintend the construction, which was commenced April 8, 1895.

At the end of the fiscal year there had been framed 200,000 feet, B. M., of hemlock timber, and 16,000 feet, B. M., of pine timber; three cribs, each 100 feet in length, were ready to sink in place, and the foundation had been dredged to solid rock for two of the cribs. A fourth crib had been commenced, and stone for filling one crib had arrived. It was expected to sink the first crib on June 29, but a strong northwest wind compelled a postponement. On the 29th of June 125 cords of stone had been delivered on vessels, ready to put into cribs as soon as weather would permit.

The outer end of first crib to be sunk on the east side will be at a distance of 500 feet from the shore, and this will be followed by four others, closing the interval between first crib and the shore. In putting on the superstructure the same method will be followed by completing the outer end first. This method, which is the reverse of that usually pursued, has several advantages: the trench for foundations will be better protected and will fill less if the outer end be closed by a crib. When heavy seas occur during construction it is always the outer end which suffers loss of stone and other consequent injury. When construction is carried outward from the shore the outer end is always necessarily incomplete and exposed; by finishing that part first the outer end is protected at once, and the remaining work is sheltered by that which preceded.

As the framing and fastenings of the cribs now under construction for Conneaut Harbor are in many respects considered to be an advance upon any work heretofore constructed, a drawing showing the design is forwarded to accompany this report. As these cribs are upon a rock foundation, the apron shown in drawings with last annual report, and used this year at Fairport Harbor, is not needed. The grillage, for convenience in launching, is built in three sections; when in the water these are placed end to end and form the bottom of cribs, each 100 feet long. The grillage timbers necessarily pass through the side walls for support. The cross walls are solid from bottom to top; the timbers are square on the ends and abut against the inner faces by walls without dovetails or other framing. These walls are held at each end between two vertical timbers secured by screw bolts, as shown in the drawings. Long rods, 1½ inches in diameter, pass through the crib from side to side to hold the outward thrust. All drift bolts are headed, but have no points save a mere beveling of the edge to prevent tearing the sides of the holes in which they are driven. Arrangement of bolts shown in drawing is such that the timbers are drawn very close together, and the whole result is to make the crib vastly more rigid and strong than by the method of dovetails.

The principal merits are, however, that the cribs are believed to be far more durable than the kind heretofore used, and when the wood above water decays the bottom is far better adapted to adding a new superstructure of masonry.

Some old crib work which had been in the water perhaps fifty years when recently removed was found to be worthless, owing to the wearing away of the dovetail heads of cross-ties and cross walls, as well as the ends of timbers framed together at angles of cribs. The water for many years, loaded with mud and sand, had been forced back and forth around these dovetails until they were so much worn that the clear space was often as great as 2 inches where the timbers should fit very close to give any strength or stiffness. It was due to the decking which held the top of the walls in place, and the fact that the stone inside

had become cemented together with hard mud so that there was no outward pressure, that the cribs had not long before fallen in pieces.

The iron driftbolts in the old cribs have been found so slightly rusted as to make no material difference in the weight or strength. It is therefore evident that a device which will do away entirely with the dovetail method of framing and rely instead upon iron for fastenings will vastly prolong the effectiveness and durability of the cribs below water.

While the faces of timbers in old cribs were also somewhat worn, yet the wear was much less than around the exposed ends, and even if as great it would not destroy the strength and effectiveness of the cribs. The pine timber above water in these works decays so much as to be practically worthless in about fifteen years. The decay is much hastened wherever timbers are cut into or otherwise injured. In the gains cut for dovetails the effect of varying degrees of moisture is far greater than it is in the timber where it is whole. On the other hand, iron bolts fit and cover the holes so tightly as to prevent any hastening of decay from that cause, so that the new method here described can hardly fail to prolong the effective strength of parts above as well as below water.

It should be remarked that the part of the work thus far constructed by this method is less expensive in labor; it admits of timber with wane edges on four sides for cross-walls, and is therefore cheaper. In respect to close fitting of all parts and to straightness of faces and stiffness in the water, it is by far the best that the officer in charge of the work has ever seen.

The balance of available funds will be expended in extending the pier on east side of the harbor. The Pittsburg, Shenango and Lake Erie Railway Company has expended a large amount of money in dredging the channel, constructing wharf frontage, and putting in railway tracks and coal hoists. As a result, a very large amount of coal and ore has been transferred at this harbor in the last year. A line of steamers is to commence running in July from Conneaut to Port Dover on the opposite side of the lake.

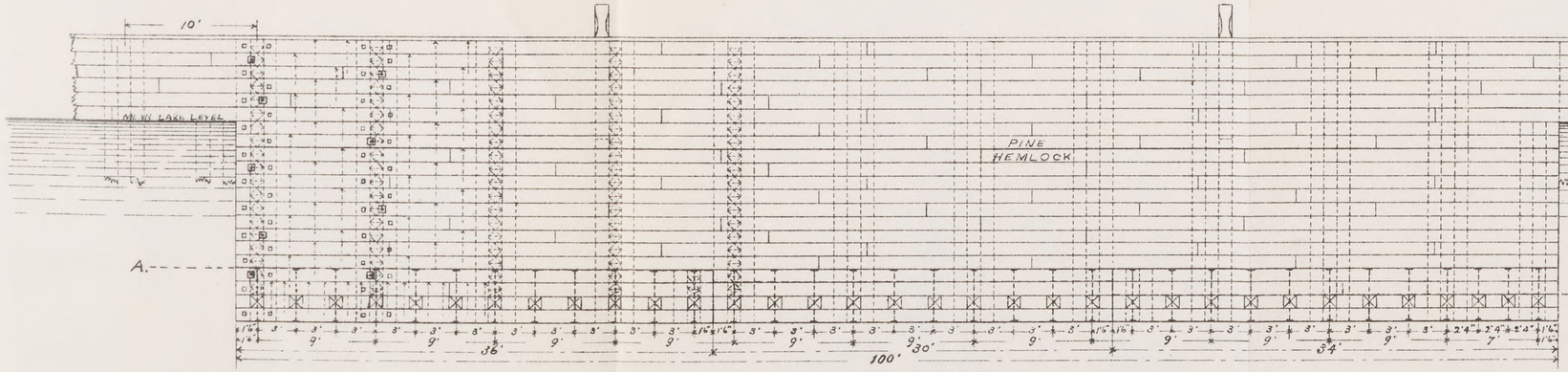
This business has all been developed in two years, and it is very desirable that the improvements of the harbor be hastened as much as possible by large appropriations, in order that the increasing business may be accommodated and navigation be made safe and convenient.

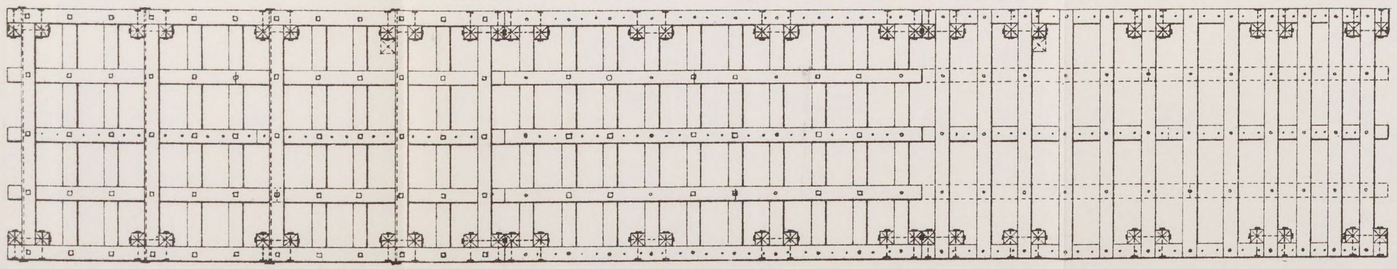
Conneaut Harbor is at the mouth of Conneaut River, 13 miles east of Ashtabula, and is near the boundary between the States of Ohio and Pennsylvania. It is in the collection district of Cuyahoga, Ohio. There is a fixed white light of the sixth order upon the bank near the mouth of the river, and a small beacon on the outer end of west pier.

Money statement.

July 1, 1894, balance unexpended		$20.94
Amount appropriated by act of August 17, 1894		40,000.00
		40,020.94
June 30, 1895, amount expended during fiscal year		16,852.59
July 1, 1895, balance unexpended		23,168.35
July 1, 1895, outstanding liabilities	$1,539.44	
July 1, 1895, amount covered by uncompleted contracts	6,105.00	
		7,644.44
July 1, 1895, balance available		15,523.91
Amount (estimated) required for completion of existing project		420,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		250,000.00

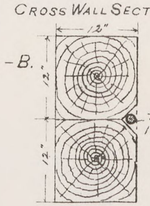
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

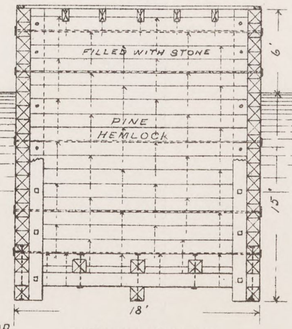


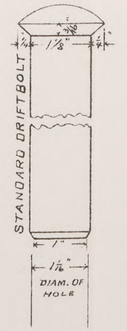


PLAN OF GRILLAGE ON LINE A-B.

NOTE—THIS CRIB STANDS ON SOLID ROCK.







CONNEAUT HARBOR, OHIO.

DESIGN FOR 100 FT. CRIB NEW EAST PIER

SCALE OF FEET

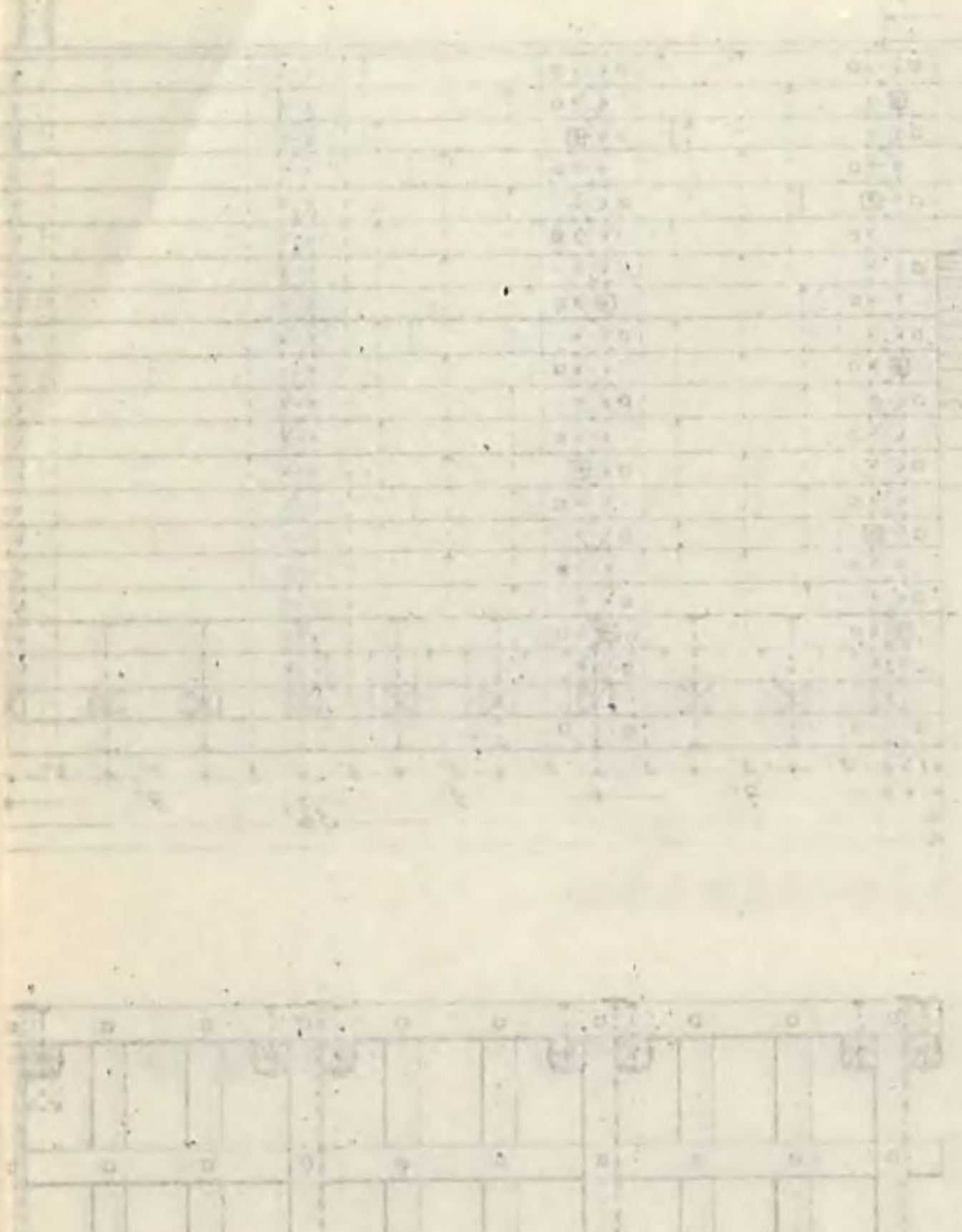
12 0 1 2 3 4 5 6 7 8 9 10 20 30 FT.

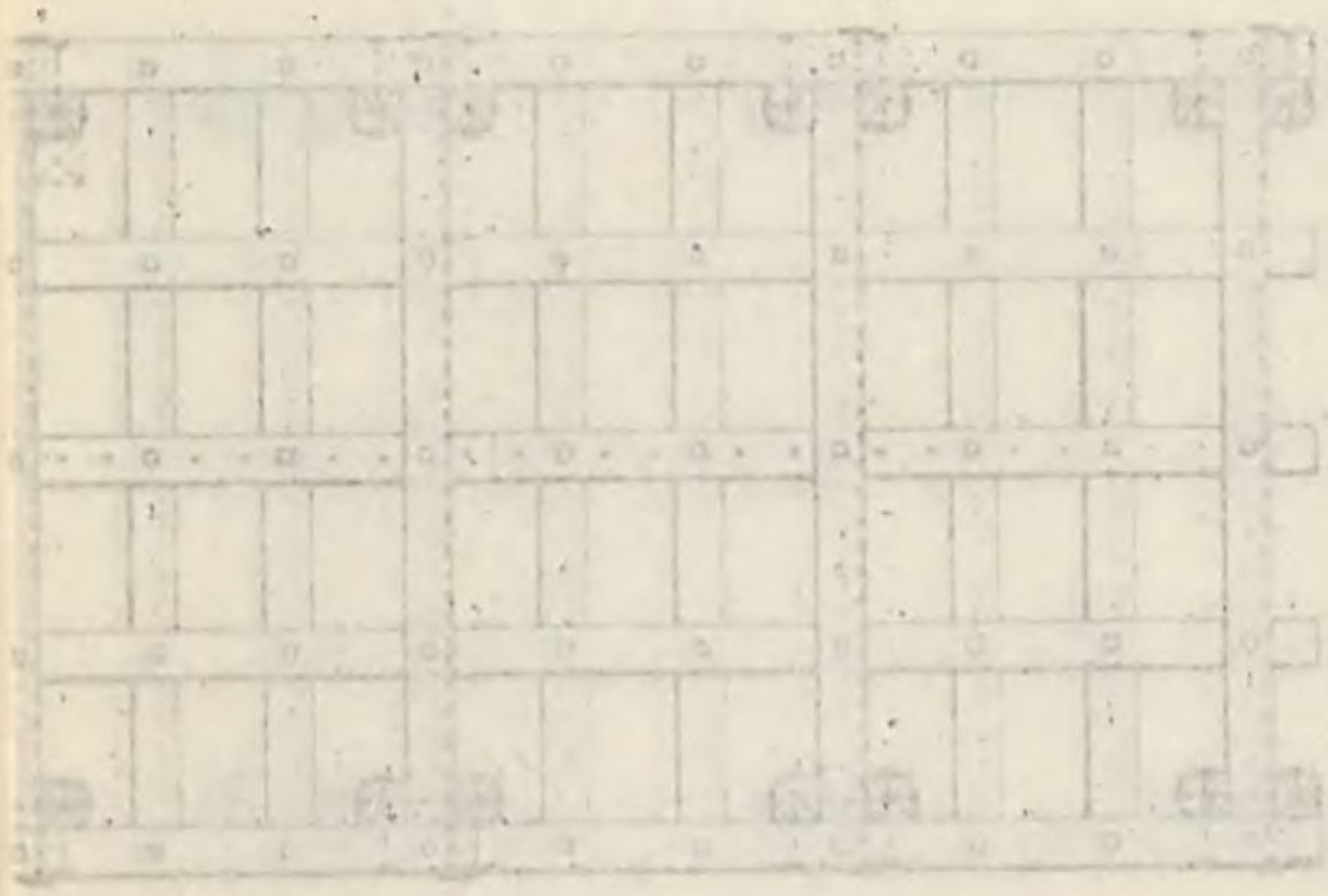
U. S. Engineer Office
Cleveland, Ohio.
To accompany Annual Report for
Year ending June 30, 1895.

Jared A. Smith

Lieut. Col. Corps of Engineers U.S. Army.

Eng 54 1





Abstract of proposals for furnishing and delivering timber, iron, and stone for construction of pier at Conneaut Harbor, Ohio, received and opened by Lieut. Col. Jared A. Smith, Corps of Engineers, at Cleveland, Ohio, on Tuesday, February 12, 1895, at 2 o'clock p. m., standard time, in accordance with advertisement dated January 16, 1895.

[Net amount available for the purpose, $22,000.]

No.	Name and address of bidder.	Timber.					
		Hemlock (444,528 feet, B. M.).		White pine (321,264 feet, B. M.).		White oak (1,872 feet, B. M.).	
		Per M. feet, B.M.	Total of bid.	Per M. feet, B.M.	Total of bid.	Per M. feet, B.M.	Total of bid.
1	Cassius M. Carrier, Carrier, Pa.	$10.00	* $4,445.28	.....	.....	.....	.....
2	C. E. Mitchell & Co., Ludington, Mich	14.85	6,601.25	$21.85	$7,019.62	$60.00	$112.32
3	Cleveland Sawmill and Lumber Co., Cleveland, Ohio	14.00	6,223.39	22.00	7,228.44	26.00	48.67
4	William Howard Prescott, Cleveland, Ohio	14.00	6,223.39	24.70	7,935.22	24.70	† 46.24
5	Emery D. Weimer, Ludington, Mich	.....	.....	21.37	‡ 6,865.41	.....	.....

* Lowest received for hemlock. † Lowest received for white oak. ‡ Lowest received for white pine.

Recommended that the contracts be awarded to Mr. Casius M. Carrier, of Carrier, Pa., for hemlock; Mr. Emery D. Weimer, of Ludington, Mich., for white pine; Mr. William Howard Prescott, of Cleveland, Ohio, for white oak, their bids being the lowest in each case.

No.	Name and address of bidder.	Iron.								Total.
		Screw bolts and washers (62,355 pounds).		Driftbolts (52,002 pounds).		Iron rods (44,449 pounds).		Spikes (2,550 pounds).		
		Price bid per pound.	Total.	Price bid per pound.	Total.	Price bid per pound.	Total.	Price bid per pound.	Total.	
1	The Hodge Manufacturing Co., Greenville, Pa.	*Cts.* 2.5	$1,558.88	*Cts.* 1.75	$910.04	*Cts.* 2.5	$1,111.23	*Cts.* 2.5	$63.75	$3,643.90
2	Wallace M. Pattison, Cleveland, Ohio	1.54	960.27	1.29	670.83	1.74	773.41	1.7	43.35	2,447.86
3	John P. McGuire, Cleveland, Ohio	1.8	1,122.39	1.4	728.03	1.85	822.31	1.17	29.84	2,702.57
4	The Upson Nut Co., Cleveland, Ohio	1.52	947.80	1.47	764.43	1.77	786.75	1.85	47.18	2,546.16
5	A. Lacour, Cleveland, Ohio	1.7	1,060.04	1.5	780.03	2.2	977.88	2.	51.00	2,868.95
6	Russel Wheel and Foundry Co., Detroit, Mich	2.14	1,334.40	1.59	826.83	2.95	1,311.25	1.98	50.49	3,522.97

Recommended that the contract be awarded to Mr. Wallace M. Pattison, of Cleveland, Ohio, his bid being the lowest received.

No.	Name and address of bidder.	Stone (1,100 cords).	
		Per cord.	Total.
1	Breckenridge & Uber, Grove City, Pa.	$5.25	$5,775
2	Kelley Island Lime and Transportation Co., Cleveland, Ohio	5.55	* 6,105
3	John Mulcahy, Greenville, Pa.	6.75	7,425

* Recommended for acceptance.

Recommended that the contract be awarded to the Kelley Island Lime and Transport Company, of Cleveland, Ohio, their bid being the lowest in accordance with specifications.

Abstract of contracts for improving harbor at Conneaut, Ohio, in force during the fiscal year ending June 30, 1895.

Contract with Cassius M. Carrier, of Carrier, Pa., dated March 6, 1895, for furnishing and delivering 444,528 feet, B. M., of hemlock timber for construction of pier at Conneaut Harbor, Ohio.

Delivery completed.

Contract with Emery D. Weimer, of Ludington, Mich., dated March 5, 1895, for furnishing and delivering 321,264 feet, B. M., of white pine-timber and plank for construction of pier at Conneaut Harbor, Ohio.

Contract completed and closed.

Contract with Wallace M. Pattison, of Cleveland, Ohio, dated March 8, 1895, for furnishing and delivering 161,356 pounds of iron, consisting of screw bolts, drift-bolts, spikes, and iron rods, for construction of pier at Conneaut Harbor, Ohio.

Contract completed and closed.

Contract with Kelley Island Lime and Transport Company of Cleveland, Ohio, dated March 15, 1895, for furnishing and delivering 1,100 cords of stone for construction of pier at Conneaut Harbor, Ohio.

Delivery incomplete. Contract time for completion, September 30, 1895.

COMMERCIAL STATISTICS.

The following statistics for the year 1894 relative to the commerce of the harbor at Conneaut, Ohio, were compiled from information furnished by the collector of customs and others:

Receipts.	Tons.	Shipments.	Tons.
Iron ore	266,453	Coal	89,023
Plaster (alabaster)	619		
Total	267,072	Total	89,023

Total freight tonnage:

1894	356,095
1893	264,554
Increase	91,541

Vessels.	Number.	Tonnage.
Entering	149	238,525
Departing	156	89,023

Total registered tonnage:

1894	327,548
1893	300,946
Increase	26,602

Draft of largest vessels using harbor, 16 feet. Largest vessels do not load to full depth. No new vessel lines were established during the year.

M M 13.

SURVEY OF ASHTABULA HARBOR, OHIO.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, February 28, 1895.

GENERAL: In compliance with requirements of the river and harbor act of August 17, 1894, making an appropriation for "Improving harbor at Ashtabula, Ohio: Continuing improvement, $75,000, including a

survey to determine what improvement thereof should be made with a view to making it a harbor of refuge and enlarging its capacity for the purposes of commerce," I have to submit the following report:

The earliest time at which the survey could conveniently be made was in October, 1894, when my assistant, Mr. William T. Blunt, with a small party, on board the steamer *Swansea*, was directed to make the survey.

In order to ascertain the condition of the bottom in the vicinity, both with reference to depth of water and character of underlying material, the survey was extended a distance of about 2 miles along the shore, including parts both east and west of the present harbor entrance.

Twenty-two lines of soundings were taken, each line being more than a mile in length; the average interval between soundings on inner half of each line was less than 50 feet and on outer half of lines less than 100 feet.

The material of the bottom was examined in forty-five places, in thirty-eight of which the rock bottom was found entirely uncovered and at all the other points rock was found covered with sand varying from a few inches to a little more than 2 feet in depth; all the sand is near the shore.

The inner ends of lines of soundings commenced in a depth of about 10 feet, and at the outer ends most of the depths exceeded 40 feet. It requires but a glance at the map to show that there is no secure anchorage for vessels in need of refuge, and a basin constructed with a view of protecting a large area for anchorage would therefore afford but very small benefit in proportion to the expense.

As a matter of fact, but a very small fraction of the commerce of the lakes is carried in sail vessels propelled by the winds, and even those are generally taken in tow by tugs on entering a harbor and are rarely brought to anchor. Masters of steam vessels do not often let go an anchor, as it gives far less trouble to proceed directly to a wharf.

In Cleveland Harbor, where there is a large area for anchorage, it is very rarely used as a refuge, and the very few vessels using it for an anchorage have as a reason that it is a secure place to remain when unemployed rather than a refuge from storms.

The fact that there is no holding ground at Ashtabula Harbor which would make a safe anchorage in storms is therefore of very little consequence in that respect.

The essential qualities to make the harbor desirable and sufficient for a refuge are an entrance of ample width and depth and such protection as shall break the force of the seas, so that vessels may easily reach places of safety alongside the piers and wharves.

Any reduction of the height of waves at the entrance between piers is equivalent in some respects to an added depth of the channel. The deep vessels entering the harbor in a heavy sea rise above and fall below the level which they would follow in smooth water, and the large vessels which could enter with safety in smooth water might pound upon the bottom and be unmanageable in a seaway. In such cases the vessels are compelled to remain outside without shelter until the sea subsides.

In heavy storms from the lake the seas chase each other into the harbor to a considerable distance; any device which will so far break the seas as to neutralize their effect at the entrance between piers and at the wharves inside will therefore be of great benefit in increasing the capacity of the harbor for purposes of commerce, though not actually enlarging its area.

There are no present indications that an enlargement of the protected area of Ashtabula Harbor outside of the shore of the lake is a necessity for purposes of commerce. The commercial business of the harbor is located inside the shore line, and the nature of the principal business—the transfer of iron ores and coal—is such that it is far more likely to remain where it has already become firmly established on the flat lands near the river channel than it is to require a protected area within the limits of the lake.

I therefore conclude that any works proposed for the improvement of the harbor, as indicated in the act of Congress before mentioned, should be limited to such as will fulfill the essential requirements of a safe entrance to vessels and protection from seas when inside.

The present piers at Ashtabula Harbor are 213 feet apart at the entrance and extend to a point where the rock bottom is at a depth below mean lake level of 16.5 feet on the east and 19 feet on the west side. The present project for improving the harbor of Ashtabula contemplates the extension of the parallel piers to a depth of 22 feet in the lake and the removal of the rock bottom between piers to a depth of 20 feet. It also includes rebuilding part of superstructure of west pier.

I forward a tracing of the map made from the survey of Ashtabula Harbor and vicinity. Upon this map is indicated the present location and extent of the piers and a portion of the harbor which has been constructed in and adjacent to the river. The greater portion of the inner harbor and the space devoted to coal and iron handling is not shown upon the map because it is not required to illustrate this report.

The amount required to complete the piers according to present project is an extension of 600 feet to the east pier and 480 feet to the west pier.

The area to which it is hoped to remove the rock to a depth of 20 feet upon funds now available is shaded upon the map. The amount required to complete the existing project of improvement is $255,000.

If breakwaters should be constructed to facilitate an entrance and increase the usefulness of the harbor for refuge and commerce, the further extension of the piers according to the present project would be rendered unnecessary and its cost would be saved. In other words, the estimated cost of a new project including effective breakwaters would not exceed the estimated cost of the present project by an amount equal to the cost of the breakwaters, but by that amount less the amount which will be required to complete the piers on present plans.

The estimated cost of completing piers is as follows:

Extending east pier 600 feet, at $95 per foot	$57,000
Extending west pier 480 feet, at $98 per foot	47,040
Contingencies, nearly 10 per cent	10,360
Total	114,400

The direction of the line of the piers and therefore of channel between them is almost exactly on the true meridian. The principal storms which cause danger or difficulty in entering the harbor are from the northeast and northwest, those from the latter direction being more numerous and generally more severe than from any other.

At a distance of 1,800 feet outside the end of west pier the water is 28.5 to 29 feet deep, which is ample for entrance of the largest vessels now contemplated on the lakes during any ordinary storm. It requires no explanation to understand that the greater the width which can be

given to a harbor entrance the less will be the difficulty of entering without collision with piers on either side. On the other hand, a very wide entrance in the outer protection at Ashtabula would permit the entrance of seas to a sufficient extent to largely reduce the benefits received from the breakwaters.

At Cleveland, Ohio, the entrance between breakwaters is 500 feet wide, and it is found to serve the necessities for width sufficiently well, although it is understood that there are at times strong currents across the entrance caused by seas chasing each other along the face of the breakwaters.

Upon the map forwarded to accompany this report I have indicated two breakwaters, one east and one west of the entrance, each at an angle of 45° from the meridian and therefore at right angles to each other. The outer ends of these breakwaters are 400 feet apart and the entrance is protected on each side by piers 50 feet square, with two sides parallel to the meridian.

The width of breakwater, as planned, is 32 feet and the cross section may perhaps be advantageously made like that at Cleveland. The lengths of these breakwaters are shown to be 1,500 feet each, besides the pierheads for extra strength, turning away seas at entrance, and for sites for beacons.

An arrangement of breakwaters in this manner will afford a sufficient width for entrance without so wide an opening as to defeat their purpose, and they will reduce the seas from any direction to a sufficient extent to greatly decrease the danger of entering the harbor and largely increase its usefulness.

At present the construction of such breakwaters by a mere riprap of stone is attended with so many difficulties, owing to the kind and cost of stone, that it is not prudent to submit an estimate for the cost of that class of work. Should the near future develop any points of advantage not now known they may be then considered. Meantime, the estimate is made on a basis of constructing the breakwaters after the general plan heretofore in use on the lakes—cribs, or caissons of timber filled with small riprap stone.

As the foundation is of solid rock the superstructure might be very easily built of stone or concrete masonry in the first instance, but as appropriations for such works are limited in amount an increase in first cost would delay the completion and the time in which the benefits would be realized. That part of the subject is therefore left for future consideration.

On the basis of the ordinary superstructure of timber work filled with stone the estimated cost is as follows:

For construction two breakwaters, each 1,500 feet long on inner face, and two pierhead cribs, each 50 feet square, at an average cost of $150 per linear foot, including contingencies	$465,000

It should be remembered that the cost of completing the present project would be reduced $114,400 by the construction of the breakwaters, so that the addition to present estimated cost of completion of project would be but $350,600.

Ashtabula Harbor is now the greatest shipping and receiving point upon Lake Erie for coal and ore. The harbor is reached by the Lake Shore and Michigan Southern and the Pennsylvania railroads. Both these railroad companies have expended large sums in improving the facilities for transfer of iron and coal.

The importance of the place as a commercial port and refuge is therefore very great.

I inclose herewith the report of Mr. William T. Blunt, United States assistant engineer, to accompany and form a part of my own.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MR. WILLIAM T. BLUNT, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, February 18, 1895.

SIR: I respectfully submit herewith a chart of Ashtabula Harbor based on a survey made in October, 1894, in compliance with river and harbor act of August 17, 1894, with reference to making a harbor of refuge.

The chart is on a scale of 1 to 4,000, and shows contours of bottom and depths to rock for nearly a mile each side of the piers and out to a depth of about 40 feet of water.

On account of inclement weather and urgency of other work it was not deemed advisable to continue the soundings close inshore as they did not seem necessary to the study of the question in hand.

I arrived at Ashtabula Harbor with the steamer *Swansea* on the evening of October 18, 1894. After the necessary preliminary work a true meridian was established from observations on Polaris October 20; and with azimuth based on this a carefully checked stadia line was run alongshore east and west from the piers determining heights of bluffs and locations of prominent objects for use in sounding. At intervals of about 500 feet ranges were established by transit on same general azimuth as that of piers—0° 18′ 30″ west of south. These ranges, being indicated by stakes and flags, were used for sounding. The soundings, except those immediately adjacent to piers, were all taken from deck of the steamer, which was run in on the range at the lowest possible speed. In water too deep for use of a rod the lead line was used with a careful test before and after using; the rod was substituted as soon as water shoaled sufficiently. Lead-line soundings could only be read to the nearest half foot, while rod soundings were read to nearest tenth. Soundings were stopped in from 8 to 10 feet depth, as it was unsafe for steamer to venture farther.

Locations on the ranges were obtained by taking a sextant angle between range and a determined point on shore at the sounding to be located. This was done generally at every fourth sounding, thus leaving a convenient number of soundings to be plotted at even spaces between.

On the main lines the soundings in deep water were from 75 to 100 feet apart, and toward the shore from 50 to 75 feet. Considering the purpose for which the survey was made, the scale of the map, and the fact that deep soundings could only be read to half feet, soundings are as close together as necessary. Should construction work be entered upon, however, a more detailed survey in the immediate vicinity would of course be required.

The area covered by soundings is 4,500 feet east and the same west from the harbor entrance and 6,000 to 7,000 feet from shore. Twenty-two lines of about 1 mile each were actually sounded. Upward of 1,700 soundings were taken on these 22 miles run aside from about 1,000 soundings taken in detail about the piers. These latter were taken to show the action of deposits near entrance. At 45 locations depths to solid rock were determined by a small steel rod attached to a sounding pole. In all places, except the immediate vicinity of shore and piers, the rock bottom is bare of all deposit. There is therefore no anchorage ground within the limits of the survey, except where too shoal for use.

Work was greatly interfered with by stormy weather, so that it was only completed on October 31.

Very respectfully,

WM. T. BLUNT,
Assistant Engineer.

Lieut. Col. JARED A. SMITH,
Corps of Engineers.

CHART OF ASHTABULA HARBOR, OHIO.

SHOWING LOCATION OF IMPROVEMENTS DESIGNED TO MAKE IT A HARBOR OF REFUGE AND ENLARGE ITS CAPACITY FOR PURPOSES OF COMMERCE

From a Survey made in October, 1894, by Wm T. Blunt, Asst. Engr.
under direction of Lieut-Col. JARED A. SMITH, Corps of Engrs. U.S.A.
and in compliance with requirements of River and Harbor Act of August 17, 1894.

U.S. Engineer Office, Cleveland, Ohio. Feby 28 1895.
Forwarded to the Chief of Engineers, with letter of this date.

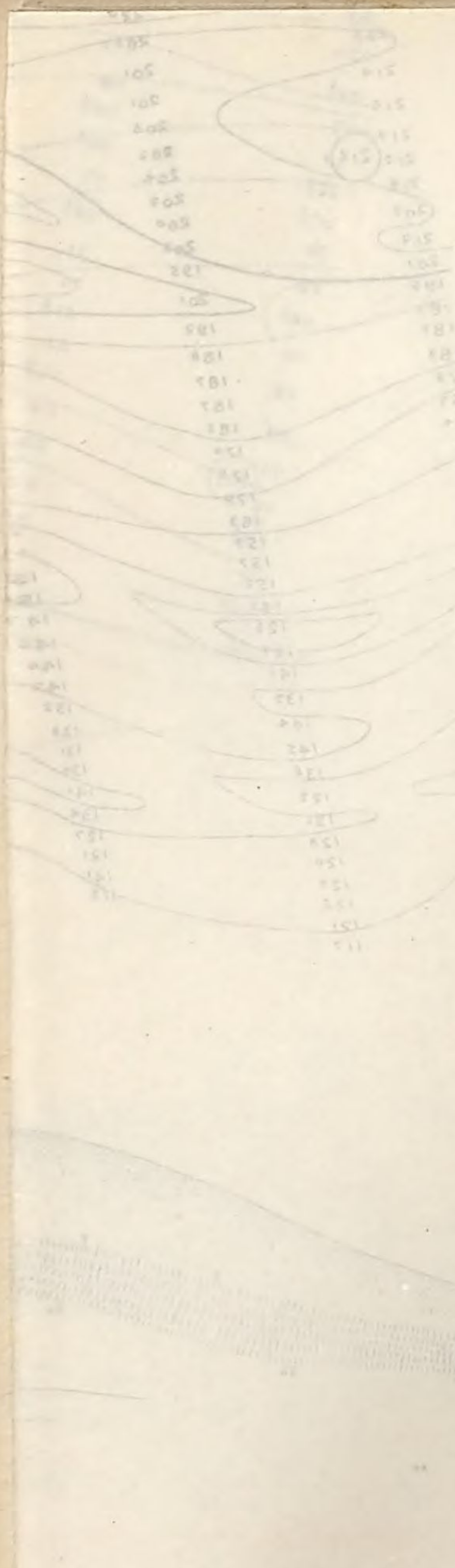
Jared A. Smith
Lieut.-Col. Corps of Engineers, U.S. Army

Depths and elevations are expressed in feet, and are reduced to Mean Level of Lake Erie, 1860 to 1875, which was 2.34 feet below High Water of 1838.

Field record in Note book No. 22.

Depths to rock bottom are inclosed in circles.

Eng 54 1



M M 14.

MODIFICATION OF HARBOR LINES IN CLEVELAND HARBOR, OHIO.

CLEVELAND, OHIO, *January 2, 1895.*

Your petitioner respectfully represents that it is the owner of the major part of the harbor property lying south of the line of navigation established by your honor in Lake Erie, and between the Cuyahoga River on the east and Lake View Park of the city of Cleveland on the west; that the fast ground at this point is a bluff of 60 feet and over in height, and that all the lands between the foot of this bluff and the waters of the lake are occupied by the main tracks, connecting tracks, depots, turntables, and other structures essential to the handling of the through business conducted by your petitioner; that whatever business may be hereafter transacted upon this property and whatever structures are located for the convenience of commerce must be confined to the comparatively small territory within the boundaries named.

Your petitioner therefore respectfully requests that a new dock line be established to be parallel with and distant at right angles 1,700 feet south of the south face of the east breakwater, being relatively the same position as that in which the dock line is fixed west of the Cuyahoga River, as shown on plat* hereto attached. Not only will this add to the amount of land available for improvement in the conduct of the commerce of this port, but it will considerably reduce the expense to the Government of the maintenance of the proper depth of water in the harbor, while allowing ample room for the anchorage and maneuvering of vessels within the same.

Your petitioner further represents that it proposes to at once proceed to the construction of piers and slips and the further improvement of the property, with a view to their use by the opening of navigation of the season of 1895, and prays that its request may be promptly granted so that this work may not be delayed.

L. F. LOREE,
Superintendent Cleveland and Pittsburg Division,
Pennsylvania Company.

Hon. DANIEL S. LAMONT,
Secretary of War.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 19, 1895.

Respectfully referred to Col. H. L. Abbot, Corps of Engineers, Division Engineer, Northeast Division, for investigation and report.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Fifth indorsement.]

NORTHEAST DIVISION, ENGINEER OFFICE,
New York, January 29, 1895.

Respectfully returned to the Chief of Engineers, U. S. A., inviting attention to the report herewith.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

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* Not printed.

REPORT OF COL. H. L. ABBOT, CORPS OF ENGINEERS.

NEW YORK CITY, *January 29, 1895.*

GENERAL: In accordance with your instructions of 19th instant, to investigate and report upon the application of the superintendent of the Cleveland and Pittsburg Division of the Pennsylvania Company for a modification of the harbor lines at Cleveland, east of the Cuyahoga River, as now established by the Secretary of War, I have the honor to submit the following report:

I have personal knowledge of the locality in question, and as the lake front here is owned by the Cleveland and Pittsburg or the Lake Shore and Michigan Southern Railroad companies where not bounded by the Lake View Park, no public meeting has appeared to be called for by your instructions.

The location of the harbor lines at Cleveland should be governed by that of the breakwaters in front.

The construction of an eastern extension of the general line of the existing west breakwater appears to have been first recommended by Major Overman, then in charge of the district, in his annual report for 1884; it was based on earnest protests against the existing project by parties interested in lake commerce.

This recommendation was referred to a special Board of Engineers, whose report is contained in the Annual Report of the Chief of Engineers for 1885. A modification of Major Overman's project was recommended, which, with further modification, was approved by the Chief of Engineers and by the Secretary of War, submitted to Congress, and authorized by act approved on August 5, 1886.

In January, 1888, resolutions favoring a further extension of the east breakwater were adopted by the Cleveland Board of Trade and Industries and indorsed by the Lake Carriers' Association of Buffalo (Annual Report of the Chief of Engineers for 1888). These papers, with a favorable report from Major Overman, approved by the Chief of Engineers, were transmitted to Congress in response to a House resolution of February 20, 1888. The river and harbor act of August, 1888, authorized this modified project, which, since that date, has been in process of execution. The entire length of the straight portion is 3,500 feet, of which 2,524.5 feet were reported as completed at the end of the last fiscal year.

The present harbor or "dock" line behind the east breakwater was established by the Secretary of War on December 23, 1889. This date was more than a year after Congress had sanctioned the present location of the east breakwater, and the line must, therefore, have been established with full knowledge of the conditions then affecting the harbor. It provides for preserving the distance of 1,700 feet between the shore and the eastern end of the breakwater, after the change of direction of the latter to exclude dangerous waves in northeasterly gales has been made.

The present application of the superintendent of the Cleveland and Pittsburg Division of the Pennsylvania Company limits the desired extension of the harbor line to the area west of the middle line of Seneca street prolonged, and does not infringe upon the normal width (1,700 feet) of the anchorage ground. The line proposed by Lieutenant-Colonel Smith, now in charge of the district, continues the proposed extension on the same straight line to the eastern end of the approved breakwater, or rather to a point abreast thereto, thus reducing the eastern entrance of the harbor to a width of, approximately, 800 feet. This extension of the line beyond what is requested lies in front of the

Lake View Park, which I understand is not available for commercial purposes.

The enlargement of the present dock facilities in the Cuyahoga River is greatly to be desired, and I see no objection to granting the requested extension of the harbor line, which will doubtless assist in this important improvement; but the further extension proposed by Lieutenant-Colonel Smith may result in restricting the available anchorage area, and especially the eastern entrance thereto, without corresponding advantage, and in my judgment it should not be granted. The fact that improper dumping has been allowed by the local authorities, which in the future may perhaps call for removal at the expense of the General Government, should not, I think, be considered in a public work of this magnitude and importance.

For the above reasons I recommend that the harbor line as now established be modified as follows: From the present intersection with the east pier at the mouth of the Cuyahoga River the line to be extended in a straight direction and at a uniform distance of 1,700 feet from the breakwater eastwardly until it intersects the middle line of Seneca street prolonged, and that from the intersection thus determined it be extended in a straight line to the most eastwardly point of the line established by the Secretary of War on December 23, 1889.

Very respectfully,

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 31, 1895.

Respectfully submitted to the Secretary of War.

Application having been made for a modification of the harbor lines at Cleveland, Ohio, the papers in the case were referred to Col. H. L. Abbot, Corps of Engineers, Division Engineer, Northeast Division, to whose report (within) attention is invited.

For reasons given, Colonel Abbot recommends that the harbor line as now established be modified as follows: From the present intersection with the east pier at the mouth of the Cuyahoga River the line to be extended in a straight line and at a uniform distance of 1,700 feet from the breakwater eastwardly until it intersects the middle line of Seneca street prolonged, and that from the intersection thus determined it be extended in a straight line to the most eastwardly point of the line established by the Secretary of War on December 23, 1889.

I concur in the views of Colonel Abbot, and recommend that the line proposed by him be approved.

The modification recommended is shown on the tracing* submitted herewith, and it is recommended that the Secretary place his approval on the tracing, which has been prepared for his signature.

This gives the Pennsylvania Company all that is asked for and all that is proposed by Mr. Hanna.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

NOTE.—The lines described in the above report and shown on the map accompanying were approved by the Secretary of War under date of February 1, 1895, the approval being indicated on the map.

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*Not printed.

M M 15.

ESTABLISHMENT OF HARBOR LINES IN FAIRPORT HARBOR, OHIO.

THE PAINESVILLE BOARD OF TRADE,
Painesville, Ohio, December 1, 1894.

DEAR SIR: Our board has taken up the matter of establishing harbor lines at our lake port, known as Fairport, Ohio.

On applying to Major Smith we were informed it would be necessary to obtain orders from the War Department before he could act. We therefore respectfully call your attention to the matter and request that he be furnished with authority to do the work desired at as early a date as possible.

Very respectfully, yours,

E. G. WETHERBEE, *Secretary.*

Hon. DANIEL S. LAMONT,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 5, 1895.

Respectfully referred to Lieut. Col. Jared A. Smith, Corps of Engineers, for report.

If in the opinion of Lieutenant-Colonel Smith the establishment of harbor lines at this locality is necessary for the preservation and protection of the harbor, he will submit with his report a tracing showing the lines which in his opinion should be adopted.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Third indorsement.]

U. S. ENGINEER OFFICE,
Cleveland, Ohio, January 5, 1895.

Respectfully returned to the Chief of Engineers with report and tracing * showing lines which are recommended for adoption.

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 8, 1895.

Respectfully returned to the Secretary of War.

The subject of harbor lines for that part of Grand River known as Fairport Harbor, Ohio, having been under consideration by Lieut. Col. Jared A. Smith, Corps of Engineers, that officer submits the accompanying report of the 5th instant, with a drawing upon which is delineated the lines which, in his opinion, should be established for the preservation and protection of the harbor.

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* Not printed.

I concur in the views of Colonel Smith and recommend the establishment of the lines selected by him and shown by heavy black broken lines on the drawing.

The drawing has been prepared for the approval of the Secretary.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Fifth indorsement.]

WAR DEPARTMENT, *January 11, 1895.*

Respectfully returned to the Chief of Engineers with drawing approved by the Secretary of War this date.

By order of the Secretary of War:

JOHN TWEEDALE, *Chief Clerk.*

REPORT OF LIEUT. COL. JARED A. SMITH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cleveland, Ohio, January 5, 1895.

GENERAL: Referring to indorsement dated Office Chief of Engineers, U. S. Army, December 5, 1894, I have to submit the following report and recommendation regarding the establishment of harbor lines in that part of Grand River known as Fairport Harbor, Ohio:

On the 12th of December, 1894, I visited Fairport Harbor with the special purpose of making inquiries and observations regarding the necessity for harbor lines.

On the east side of the harbor is the village or corporation of Fairport in the township of Painesville.

The Pittsburg, Painesville and Fairport Railroad has a terminus on that side of the harbor, and for several years a very large business has been carried on in the handling and transfer of iron ores and coal.

The wharf front on the east side for a distance of about 4,500 feet, in addition to a slip about 1,000 feet long, tracked on both sides, has been built and occupied for business purposes. This wharf front varies but slightly from the straight lines on which it was intended to be built, conforming approximately with the original shore lines.

It therefore apears to be both right and expedient to adopt as harbor lines on the east side the straight lines of the wharf front corresponding approximately with the lines as built, except above the slip where the end of a coal dock (or wharf) has been built somewhat beyond the natural bank of the river.

The west side of the river, known as Richmond, in the township of Painesville, is principally low, sandy, or swampy land, entirely unoccupied for business purposes, except at a distance of somewhat more than a mile inside the shore line, where there is a large elevator and two very large warehouses, with a substantial wharf front built to correspond very closely with the original river bank. It is therefore desirable to adopt the front line of the warehouse wharf as the harbor line at that place.

The width between piers at the entrance was intended to be 200 feet, and would have been so but for the movements of cribs by storms during construction. There are, however, places where the full width is preserved, and it is very desirable to maintain that width in all places where it can not be made wider.

The handling of large steamers with heavy freights in the harbor makes a greater width than 200 feet or even 300 feet, were it practicable, a matter of great importance. With that fact in view, the reason for the locations of the lines recommended for adoption on the west side will be sufficiently apparent on examining the map.

It appears that the necessity for establishing harbor lines at this time arises from the fact that extensive improvements for business purposes are contemplated for the west side, and it is essential to the preservation of the harbor that these limiting lines should be established before the construction of wharves has been commenced.

There seems to be no immediate necessity for establishing harbor lines farther up the river than those indicated upon the tracing in heavy black broken lines.

In order that the lines of both sides may have definite points of reference, distances are indicated to certain fixed points which are known and are matters of record. The points and distances are indicated upon the tracing.

Very respectfully, your obedient servant,

JARED A. SMITH,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

MODIFICATION OF HARBOR LINES IN FAIRPORT HARBOR, OHIO.

BALTIMORE AND OHIO RAILROAD COMPANY,
OFFICE OF THE SECOND VICE-PRESIDENT,
Baltimore, Md., June 17, 1895.

MY DEAR SIR: This will be handed to you by Mr. W. T. Manning, chief engineer of the Baltimore and Ohio and Pittsburg and Western railroads, who wishes to see you in connection with Colonel Smith, United States Engineers, in charge of the harbor at Fairport, looking to certain changes of pier line, etc.

I will be very glad if you can see your way clear to approve of the changes suggested in reference to the lines now at Fairport Harbor.

Yours, very truly,

THOS. M. KING,
Second Vice-President.

Hon. DANIEL S. LAMONT,
Secretary of War.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
June 17, 1895.

Respectfully returned to the Secretary of War.

Under your personal instructions I have looked into this case and find no objection to change of harbor lines proposed herein, which is recommended for approval.

In further compliance with your authority telegraphic notice has been sent to Colonel Smith to withdraw objection to the construction of the wharf as herein shown.

WM. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

Respectfully returned to the Chief of Engineers.

The approval of the modified harbor lines by the Acting Secretary of War is shown on the inclosed tracing and blue print.

By order of the Acting Secretary of War:

J. B. RANDOLPH,
Acting Chief Clerk.

WAR DEPARTMENT, *June 20, 1895.*

RESOLUTION OF THE RIVER AND HARBOR COMMITTEE OF THE PAINESVILLE, OHIO, BOARD OF TRADE.

PAINESVILLE, *June 14, 1895.*

At a special meeting of the committee on river and harbor of the Board of Trade of Painesville, Ohio, called for the purpose of considering harbor lines, the following preambles and resolution were unanimously adopted:

Whereas the Board of Trade of Painesville, Ohio, at a stated meeting directed the secretary to communicate with the Hon. Daniel S. Lamont, Secretary of War, looking to the establishing of harbor lines at the port of Fairport, Ohio, to which favorable consideration was given, the necessary survey made and reported by Lieut. Col. Jared A. Smith, in charge, and approved by the Secretary of War on January 11, 1895; and

Whereas in consideration of the fact that this survey was not submitted to the board of trade for approval or to the owners of property fronting on the river; and

Whereas under the survey as made and approved by the Secretary of War it has become necessary to ask that a change be made in that portion of the established lines, as will be more fully set forth in the accompanying map,* which is made part of this petition: Therefore

Resolved, That we, the committee on river and harbor, approved by the president and attested by the secretary of the board of trade, do hereby recommend to the honorable the Secretary of War that such changes in the river lines as are shown on the map hereto attached be made, to the end that the work now in process of construction may be pushed to completion without serious loss or damage to the eompany in charge of the work.

J. S. CASEMENT,
I. K. PIERSON,
J. B. BURROWS,
J. R. IRVIN,
S. CHAPMAN,
Committee.

Approved:
C. O. CHILD,
President of the Board.
Attest:
E. G. WETHERBEE, *Secretary.*

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* Not printed.

APPENDIX N N.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA, AND OF RIVERS AND HARBORS IN WESTERN NEW YORK.

REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Erie Harbor, Pennsylvania.
2. Presque Isle Peninsula, Erie Harbor, Pennsylvania.
3. Dunkirk Harbor, New York.
4. Buffalo Harbor, New York.
5. Tonawanda Harbor and Niagara River, New York.
6. Niagara River from Tonawanda to Port Day, New York.
7. Wilson Harbor, New York.
8. Olcott Harbor, New York.
9. Oak Orchard Harbor, New York.

EXAMINATION.

10. Dunkirk Harbor, New York.

HARBOR LINES.

11. Outer Harbor, Buffalo, N Y.
12. Niagara River in the vicinity of Ferry street, Buffalo, N Y.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., July 3, 1895.

GENERAL: There are inclosed herewith the annual reports of the various works of river and harbor improvement under my charge for the fiscal year ending June 30, 1895. * * *

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

N N 1.

IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA.

Object.—The object of this improvement is twofold:

1. To protect the harbor from severe winds from the east and northeast.

2. To obtain and maintain a channel between deep water in the harbor and the open lake, 16 feet deep at low water and of navigable width.

Project.—The project, as originally prepared in 1823 and approved in 1824 (at which time the entrance to the bay was narrow and tortuous and only 6 feet in depth), provided for closing all of the eastern end of the harbor by means of a breakwater, in which should be left an opening 200 feet wide, and for extending to deep water in the lake two parallel piers, one on each side of the opening. This project is substantially in force at the present time, excepting that the piers are 350 feet apart.

Present works.—The present works consist of (1) a breakwater lying north and south from the main shore to the south side of the entrance to the harbor; (2) a pier on the south side of the entrance channel, nearly east and west in position; (3) a pier on the north side of the channel, parallel with and 350 feet distant from the pier before mentioned, and (4) a catch-sand jetty, built in 1883, about 3,000 feet north of the north pier, for the purpose of arresting the movement of sand into the channel.

The construction of this jetty is such that it does not serve the purpose for which it was built, and it has received no repairs since its construction. These works are known as (1) the south breakwater, (2) the south pier, (3) the north pier, and (4) the catch-sand jetty.

The piers and breakwater consist of timber crib work, filled with stone and covered with pine plank deck.

The catch-sand jetty consists of a single row of piles driven close together and bound together with oak walings.

OPERATIONS DURING THE FISCAL YEAR.

Repairs to piers and breakwater.—On the north pier decayed deck plank were renewed where necessary, loose spikes driven down, and two snub posts straightened and refastened. These repairs were made August 23–29, 1894. The cost of repairs was as follows:

Plank and spikes	$29.48
Labor	33.00
Total	62.48

Surveys.—No surveys were made during the year. Examinations of the channels were frequently made and the water gauge tested and maintained in good order.

Surveillance of the peninsula.—The watchman was on duty during the entire year. He enforced the rules in regard to the building of fires and cutting of trees or any growth on the peninsula, so far as possible over so large an area (about 4 square miles). No depredations were committed.

Fires occurred as follows: August 11, 1894, a fire was started in some unknown manner in the marsh at the west end of the peninsula. The watchman and two laborers worked all night putting out the fire, and the life-saving crew rendered efficient assistance for about two hours. The fire was confined to grass in the marsh.

August 13, 1894, a fire occurred on the outer ridge, east of the Presque Isle Light. The watchman, light keepers, and life-saving crew worked all day putting out the fire, which was confined to the grass along the ridge for a distance of one-half mile and checked before any damage was done to large growth.

In addition to his duties on the peninsula, the watchman maintained a careful watch over the dumping of dredgings and required all dumping to be done in the lake, 1 mile out; cared for the public property in

storage; supervised repairing and cared for the steam launch, and acted as engineer of the launch during the season of navigation.

Dredging in channels.—At the beginning of the fiscal year arrangements had been made for removing a shoal in the north half of the outer channel, beginning about 100 feet east of the end of the north pier. The dredge engaged for the work did not become available until September 12, 1894. Dredging was then begun, and completed on October 20, 1894. An area 225 feet long and 300 feet wide, on which there was a least depth of 14½ feet at mean lake level, was dredged to a depth of 18 feet at low water—19½ feet at mean lake. On the completion of the dredging the entire channel was again clear, being not less than 17 feet deep at low water.

Total amount of material (sand) dredged	cubic yards..	6,235
Total cost of dredging		$1,455.30
Cost per cubic yard, scow measure	cents..	23.3

Repairing steam launch.—The steam launch was thoroughly overhauled and repaired in June, 1895.

CONDITION OF THE WORKS.

South breakwater.—This structure is old and much decayed. Its total length is 2,024 feet; height above mean lake level, 1½ feet; width, 6 to 12 feet. At the close of the year the structure was intact, but required minor repairs after every severe storm.

South pier.—Length of this pier is 1,220 feet. The pier is in a fair condition, but the timbers of the superstructure are becoming soft and show decay. Along the portion of the pier not decked over, 650 feet in length, some of the stone filling has been washed out. This portion of the pier will soon require new superstructure for a length of 650 feet and a height of 3 feet, refilling with stone, and the addition of a deck to protect the stone filling.

North pier.—This pier is 2,737 feet long. The westerly 993 feet is old but intact, the timberwork being too old and too soft to admit of more than patchwork to the deck. With the exception of 30 feet at the west end of the pier, over which new superstructure was placed by the Light-House Department in December, 1893, to secure Erie Range Beacon No. 1, new superstructure will be needed over this older portion of the pier, 963 feet long, in the near future. The remainder of the pier is in good condition and needs no repairs at present.

Catch-sand jetty.—About 450 feet of the jetty remain. It has been abandoned and is not considered worth repairing.

The channel.—Shoaling is gradually taking place about the harbor entrance. The total length of the channel from the 18-foot contour in the lake at low water to the same contour in the harbor is now about 7,150 feet, made up as follows:

From 18-foot contour in the lake to the east or outer end of the north pier, outer channel	feet..	1,000
Between piers	do...	2,750
From west or inner end of piers to 18-foot contour in harbor, inner channel	feet..	3,400

The width of the channel when completely clear is 300 feet. A length of channel of 2,000 feet, lying between the piers, is kept thoroughly scoured out by the strong currents which run in and out and thus maintain it in good condition at all times. The outer and inner channels require repeated dredging in order to maintain them at the required depth. At the close of the year the entire channel was in good condi-

tion, the depth of water being 18 to 20 feet at mean lake level, or not less than 16½ feet at low water, for a channel width of not less than 275 feet.

PROPOSED OPERATIONS.

Repairs to piers and breakwater.—Minor repairs to all structures will be made as damage occurs from time to time.

No repairs are advisable on the north and south piers at present. The old portions of both structures have been patched, and further patching is not advisable. The entire renewal of the superstructure, preferably with concrete, of the westerly 963 feet of the north pier and of 650 feet of the south pier will be necessary in the near future. The cost of rebuilding the superstructure is estimated as follows:

For the north pier, 963 feet	$20,000
For the south pier, 650 feet	13,000

As above stated, it would be preferable to construct the new superstructures of concrete for the following reasons: A permanent structure would thus be secured; a structure of small cross section could be used, as the piers are exposed to only moderate wave force; and conditions are favorable to making the concrete at a moderate cost, owing to the fact that an unlimited quantity of good sand and shingle is at hand on the bar lying against the north pier. In order to determine the kind and quality of cement, in mixture with the sand and shingle on the bar, best adapted for the pier superstructures, it is proposed to combine experiment with utility by constructing a section of concrete wall on the neck of the peninsula, at the west end of the harbor, wherein different mixtures of Portland and natural cements and the sand and shingle, as found in situ, would be used.

In this way not only could the best mixture be determined which could advantageously be employed upon all of the harbor works at Erie, but the security of the neck of the peninsula would be enhanced at the same time.

The liability of a breach through the neck occurs during severe storms, when the "wash" of the seas on the weather beach reaches to the crest of the neck and, "spilling over," the water runs down the other slope to the bay or harbor, producing gullies across the neck which, in a very severe storm, would become large enough to carry a large quantity of water. The resultant scour would soon form a breach through the neck.

No doubt the most effective preventive to this danger would be the construction of a wall along the crest of the neck.

It will readily be seen that much valuable information will be derived from the work proposed, both in the matter of protecting the harbor of Erie and in the matter of determining the best and cheapest concrete mixture adapted not only to the local works, but to those at other lake harbors.

It is proposed to construct a section of wall about 500 feet in length, 12 feet wide, and 8 feet high along the crest of the neck at a point where seas have washed across the neck during storms. This crest is 4 to 5 feet above mean lake level.

The wall would be founded upon the natural sand and shingle, in a trench dug to about mean lake level and 3 to 4 feet below the crest level. The wall would project 4 to 5 feet above the crest. All of the sand and shingle removed from the trench would be utilized in the manufacture of the concrete and the required additional amount of material "borrowed" from the neck formation near the wall.

It is estimated that the material at hand is composed of 1 part beach stones and pebbles to 2 and 3 parts of clean lake sand. This material would be used in mixture with cements, both Portland and natural, in various proportions in constructing the wall, and it is believed that a concrete composed of 1 part cement to 6 to 8 parts of the neck formation will prove of good weathering quality.

The cost of the work, involving the use of various brands of cement, is estimated at $4 per cubic yard in place. For a length of wall 500 feet long and 12 feet by 8 feet in section, 1,800 cubic yards, the estimated cost is $7,200.

Dredging.—Sand bars are liable to form suddenly across the harbor entrance during northeast storms. When necessary, dredging to clear the channel should be promptly done and should include a general clearing out of the entire channel throughout its entire length to a depth of 18 feet at low water. All of this dredging could be most advantageously done under one contract.

REMARKS.

The bar formation above the north pier continues to grow and encroach upon the pier and channel. While this encroachment has not been so rapid during the past year as in previous years, it nevertheless continues to such an extent that further extensions of the north pier, from time to time, seem inevitable.

The advance of the shore line outward toward the end of the pier was 200 feet during the past three years.

A comparison of the surveys of 1891 and 1893 shows but little change in the bar shore lines, excepting the advance lakeward immediately above the pier, as stated above, and the recession due to erosion at the point, at the old catch-sand jetty. This recession is shown by the surveys to have been about 160 feet in two years. No change of note in the off-shore depths has taken place.

As yet the only evidence of another bar formation, off shore from the present shore line, is the slight advance lakeward of the contour of the 5-foot depth and the formation of shoals between this contour and the shore line. This formation will, no doubt, continue more or less rapidly from year to year. The source of supply of material added to the bar continues to be the extreme easterly point of the peninsula. As the shore line of the bar advances lakeward, however, and the recession of the point in an opposite direction tends to form a straight shore line from point to pier, the erosion at the point gradually decreases and probably in time will cease.

The situation at present, however, reaffirms the opinion advanced in the last annual report that provision should be made for a further extension of the north pier. An extension of 300 feet would furnish protection to the channel entrance for several years. Since the bar formation began to threaten the channel, in 1875, the pier has been extended three times, viz: In 1880, 242 linear feet; in 1891, 452.15 linear feet, and in 1893, 301.4 linear feet. The pier work in all of the extensions is 24 feet wide and 24 feet high, the superstructure being 8 feet high above water.

The outer end of the pier has now reached a point where exposure to greater wave force demands greater stability than that afforded by the section heretofore used. The width of the pier structure should be increased to 30 feet. The cost of an extension of 300 feet, 30 feet wide, at $100 per linear foot, would be $30,000.

The existing project provides for the further extension of the south pier. To complete the project would require an extension of 1,000 feet, at a cost of $65,000. This extension is not considered advisable or necessary under existing conditions. Proposed operations may be confined, therefore, to repairs to piers and breakwater, dredging in channels, and the construction of further pier extension.

The amounts needed for repairs and dredging can not be definitely stated, as damages by storms are liable to occur at any time. Provision should, however, be made for emergencies. I would therefore estimate the expenditures as follows:

Pier extension	$30,000
Rebuilding superstructures	33,000
Repairs to piers and breakwater	5,000
Dredging in channels	15,000
Protection wall on peninsula	7,200
Total	90,200

Statement of appropriations and allotments made for improving harbor at Erie, Pa., from 1823 to the present time.

May 26, 1824	$20,000.00	March 3, 1875	$80,000.00
March 25, 1826	7,000.00	August 14, 1876	40,000.00
March 2, 1827	2,000.00	June 18, 1878	25,000.00
May 19, 1828	6,223.18	March 3, 1879	25,000.00
March 3, 1829	7,390.25	June 14, 1880	25,000.00
March 2, 1831	1,700.00	March 3, 1881	20,000.00
July 3, 1832	4,500.00	August 2, 1882	20,000.00
March 2, 1833	6,000.00	July 5, 1884	50,000.00
June 28, 1834	*23,045.00	August 5, 1886	37,500.00
March 3, 1835	5,000.00	August 11, 1888	23,000.00
July 2, 1836	*15,122.80	September 19, 1890	40,000.00
March 3, 1837	15,000.00	July 13, 1892	40,000.00
July 7, 1838	30,000.00	1823, allotment	150,000,00
June 11, 1844	40,000.00	1864, allotment	15,000.00
August 30, 1852	30,000.00	1868, allotment	40,000.00
June 23, 1866	36,961.00	1869, allotment	22,275.00
March 2, 1867	25,000.00	1871, allotment	10,000.00
June 11, 1870	20,000.00	August 17, 1894	10,000.00
March 3, 1871	29,000.00		
June 10, 1872	15,000.00	Total	881,867.23
June 23, 1874	20,000.00		

Money statement.

July 1, 1894, balance unexpended (includes $20,000 reserved for Presque Isle)	$45,364.85
Amount appropriated by act of August 17, 1894	10,000.00
	55,364.85
June 30, 1895, amount expended during fiscal year	3,675.04
July 1, 1895, balance unexpended	51,689.81
July 1, 1895, outstanding liabilities	80.00
July 1, 1895, balance available	51,609.81

* Two appropriations.

COMMERCIAL STATISTICS OF ERIE HARBOR, PA.

Arrivals and departures of vessels for the year ending December 31, 1894.

Vessels	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Steamers	1,056	1,407,595	54	16,185	1,070	1,417,849	48	8,181
Sailing vessels and barges	180	104,068	50	5,653	183	107,305	46	2,699
Total	1,236	1,511,663	104	21,838	1,253	1,525,154	94	10,880

Greatest draft of vessels, 17 feet.
Increase of tonnage, 1894 over 1893, 1,367,913.
Amount of revenue collected fiscal year ending June 30, 1894, $7,463.74.
Value of foreign imports, $19,603.83.
Value of foreign exports, $20,412,40.
Value of Canadian wheat entered through the port of Erie for export, $164,706.40.
Enrolled tonnage, port of Erie, 1894, 36,598 tons.

Imports and exports by lake, year ending December 31, 1894.

IMPORTS.

[Tons of 2,000 pounds.]

Articles.	1890.	1891.	1892.	1893.	1894.
Merchandise	42,857	21,611	37,491	68,374	86,120
Barley	2,644	1,923	1,900	1,825	9,640
Corn	200,721	58,720	147,256	210,770	74,252
Oats	80	2,905	.....	5,743	80
Rye	6,888	17,440	10,915	6,232	2,656
Wheat	45,354	206,152	237,630	101,051	67,665
Flaxseed	1,500	14,690	7,866	6,877	2,055
Malt	.....	.....	.....	.....	516
Flour	143,428	97,198	200,190	170,438	219,289
Lumber	20,379	14,249	21,567	12,843	14,463
Laths	.....	352	343	135	93
Shingles	110	.....	20	.....	.....
Stave bolts	2,488	1,500	863	.....	.....
Poles	.....	.....	.....	.....	111
Ties	.....	.....	.....	.....	909
Iron ore	554,403	441,669	720,504	549,205	644,209
Pig iron	11,507	5,175	4,432	.....	741
Copper	3,523	.....	704	2,410	14,595
Lead	.....	.....	.....	5,544	11,535
Limestone	24,414	14,343	5,626	12,991	.....
Stone	.....	4,668	.....	.....	.....
Plaster	9,295	15,169	1,784	21,294	14,614
Produce	5	3	12	.....	.....
Ice	4,700	.....	.....	.....	.....
Phosphate	500	.....	.....	.....	.....
Total	1,033,796	917,757	1,399,103	1,180,732	1,163,543

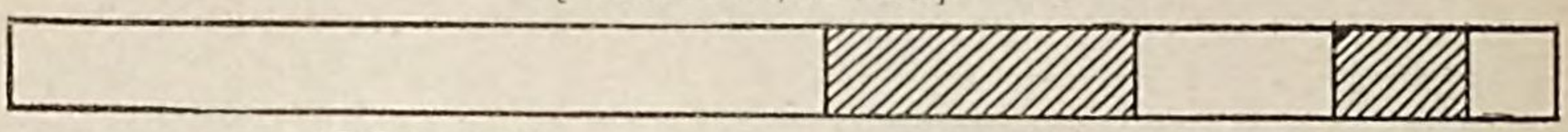
EXPORTS.

[Tons of 2,000 pounds.]

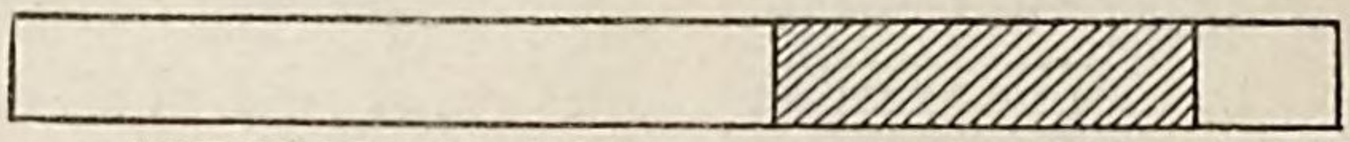
Anthracite coal	332,666	470,716	428,735	338,973	474,887
Bituminous coal	234,266	176,704	133,675	78,387	265,037
Pig and manufactured iron	4,017	.....	400	.....	.....
Merchandise	127,074	109,030	110,592	45,918	89,187
Tar and oil	1	2	.....	.....	.....
Stone	1,836	.....	550	.....	.....
Timber	400	.....	.....	.....	.....
Total	700,260	756,452	673,952	513,278	829,111

Erie Harbor, Pennsylvania, imports, 1894.

[1 inch = 300,000 tons.]



Exports, 1894.



N N 2.

PRESERVATION AND PROTECTION OF PRESQUE ISLE PENINSULA, ERIE HARBOR, PENNSYLVANIA.

This peninsula forms the harbor of Erie, which is a landlocked bay about 5 miles long, having a maximum width of 1½ miles. The peninsula is a low, sand formation about 6 miles long, varying in width from 300 feet at the "neck," which is nearly 2 miles long and joins the body of the peninsula to the mainland at its western end, to 1½ miles at its widest part. The preservation of the peninsula is of vital importance to Erie Harbor, and it is for the purpose of preserving the harbor that the protection of the weak parts of the peninsula formation has been deemed necessary. The weak portion is the long, narrow neck at the western end. The object for which all the works of protection have been constructed is the prevention of a breach through this narrow neck. The danger exists during severe storms from the westward.

At the present time no works exist excepting a few dilapidated pile jetties no longer of service, and the main line of piles, mattresses, and stone ballast on mattresses of the shore protection partially constructed in 1889.

There were no severe storms during the fiscal year 1895, and, as the stage of water was exceptionally low throughout the year, no damage was done.

The accumulation of sand at the south or inshore end of the protection work continues to increase, but no accretion is noticeable along other parts of the work.

Along the lake front, extending a mile or more west from the flash-light house, the gradual wearing away of the bank continues, but as the peninsula is here one-half mile or more wide, the safety of the harbor is not threatened at this point. There was no work done on any of the protection works during the year. A report of the Board of Engineers on the construction of shore protection for the peninsula at Erie Harbor, Pennsylvania, was published in Annual Report of the Chief of Engineers for 1890, page 2800. In accordance with the recommendation of the Board and the approval of the Chief of Engineers, $20,000 of the funds available for the improvement of Erie Harbor are reserved to close any breach which may occur in the neck of the peninsula.

At least a part of this fund could be profitably expended in the construction of a protection wall, as proposed in the foregoing report for Erie Harbor.

COMMERCIAL STATISTICS.

The commercial statistics are the same as those submitted for Erie Harbor.

Appropriations made for the preservation and protection of Presque Isle Peninsula, Erie Harbor, Pennsylvania, August 11, 1888, $60,000.

N N 3.

IMPROVEMENT OF DUNKIRK HARBOR, NEW YORK.

Object.—The object of this improvement is to form an artificial harbor in the indentation of the shore line of Lake Erie in front of the city of Dunkirk, N. Y.

Project.—The original project was adopted in 1827, and with its subsequent modifications provided for the construction of a pier running out from the west shore of the indentation and a detached breakwater parallel with the pier and about 2,000 feet distant from the city front. An opening between the two structures provided a harbor entrance through which a channel leading to the docks was to be deepened to 13 feet. By 1832 the sum of $28,439.84 had been expended on the original plan, and a breakwater was then 2,564 feet long, and the pier 1,400 feet long. Subsequently various improvements and repairs were made. In 1848 the breakwater was demolished.

In 1870 the question of the improvement of this harbor was referred to a Board of Engineers. The Board recommended a plan which provided for a detached breakwater 2,860 feet long, one part of which, 2,300 feet long, was to be nearly parallel with the shore, the other part to be nearly parallel with the axis of the channel entrance, 560 feet long and terminating at the position of the dumb beacon.

This breakwater and the pier already built were to form the harbor, and the old channel was to be enlarged to 170 feet wide and 13 feet deep. This project is in force at the present time.

Present works.—The present works consist of an unfinished detached breakwater 1,991 feet in length, a part of the 2,300-foot section provided by the project, a pier 1,410 feet long, exclusive of light-house crib, and a channel 100 feet wide and 13 feet deep. The breakwater and pier consist of timberwork, the cribs being filled with stone and decked over.

OPERATIONS DURING THE FISCAL YEAR.

Minor repairs were made to the deck and walings on the west pier in July, 1894. The total cost of these repairs was $57.43.

No dredging was done during the year.

Under contract with J. B. Donnelly, Buffalo, N. Y., dated December 19, 1894, an extension of the breakwater 400 feet easterly was begun on February 4, 1895, and fully completed on April 11, 1895. An unusually fine condition of ice enabled the contractor to build the cribs for this work, two of them being 150 feet in length and one 100 feet in length, in place, and to transport all of the material entering into the structure over ice up to within three days' work of completion of the contract.

The total cost of the extension, 400 feet in length, was	$17,851.49
Cost per linear foot of completed structure	44.63

In accordance with an act of Congress dated March 2, 1895, a survey of the harbor was made in March–April, 1895. Included in this survey was the careful determination of the depth to rock over the entire area of the harbor and its entrance.

At the close of the fiscal year a map of the harbor was in preparation and will be completed early in the coming year.

CONDITION OF THE WORKS.

Breakwater.—The breakwater is in fair condition. The structure is intact throughout, and the timberwork sound enough to endure for some years with the exception of the slope, which is much decayed in many places and will require repairs annually.

West pier.—The westerly 420 feet are buried in the sand and need no longer to be kept in repair. The next following 434 linear feet of pier is much decayed, but will probably endure for a time, being in shoal water. The next following 110 feet is new. The next following 180 feet is intact, but much decayed, and will require renewal in the near future. The remainder of the pier, 266 feet, is nearly new and in good condition.

The channel.—The channel to be maintained is about 2,800 feet long, 170 feet wide, and 13 feet deep, extending from the 14-foot curve in the lake to the city docks.

In June, 1894, the entire channel way was dredged to the required depth of 13 feet at mean lake level for a width of channel of 120 feet, and a basin 100 feet wide dredged along the entire city dock front 800 feet in length.

The channel was entirely clear for the width noted, 120 feet, excepting that at Buoy No. 4, in the inner channel, about 20 feet inside of the westerly channel line, there is an outcrop of rock about 12 feet in length, over which the depth of water is 12½ feet at mean lake level. The bottom of the harbor is mud overlying bed rock. The mud flows readily and soon fills the channel way, reducing the depth of water to 10 to 11 feet.

PROPOSED OPERATIONS.

Breakwater.—If not damaged by storms only minor annual repairs will be needed on the breakwater for the next two years.

Pier.—The section of old superstructure on the pier, lying between the new work constructed in 1889, 1891, and 1893, 180 linear feet, should be rebuilt. With this section rebuilt the more important half of the pier would be virtually new work. The reconstruction of the less important or inshore half can be postponed for a time, but repairs will be needed annually.

The channel.—The channel is 13 feet deep at mean lake level and 120 feet wide from the lake to the city docks, and there is a basin 100 feet wide and 13 feet deep along the entire dock front of 800 feet. Although the channel is not stable, it should remain adequate for the commerce of the port without redredging for at least one year. An increase in the width of the channel from 120 feet to 170 feet (50 feet) is still required to complete it, as provided by existing project.

The cost of the needed repairs in existing structures is estimated as follows:

Repairs to breakwater and pier	$2,500
Rebuilding 180 linear feet of pier superstructure	7,200
Total	9,700

The work to be done to complete the existing project is estimated as follows:

Completing channel:	
Dredging 7,000 cubic yards of sand, at 40 cents	$2,800
Blasting and dredging 4,000 cubic yards of rock, at $2	8,000
Construction of breakwater arm, 560 linear feet, at $70	39,200
Day beacon	5,000
Construction of 310 linear feet of breakwater, at $70	21,700
Total	**76,700**

Statement of appropriations and allotments made for improving harbor at Dunkirk, N. Y., from March 2, 1827, to the present time.

March 27, 1827	$3,000.00	June 10, 1872	$25,000.00
May 19, 1828	6,000.00	March 3, 1873	48,132.95
March 3, 1829	9,812.75	June 23, 1874	35,000.00
April 23, 1830	1,342.75	March 3, 1875	35,000.00
March 2, 1831	*7,102.50	August 14, 1876	18,000.00
July 3, 1832	10,200.00	June 14, 1880	10,000.00
June 28, 1834	4,000.00	July 5, 1884	10,000.00
March 3, 1835	†10,988.43	August 5, 1886	20,000.00
July 2, 1836	11,000.00	August 11, 1888	15,000.00
March 3, 1837	15,000.00	September 19, 1890	20,000.00
July 7, 1838	10,000.00	July 13, 1892	20,000.00
June 11, 1844	5,000.00	August 17, 1894	20,000.00
August 30, 1852	30,000.00	1869	†2,000.00
March 2, 1867	100,000.00	1879	†2,000.00
July 11, 1870	25,000.00		
March 3, 1871	25,000.00	Total	554,079.38

Money statement.

July 1, 1894, balance unexpended	$4,621.41
Amount appropriated by act of August 17, 1894	20,000.00
	24,621.41
June 30, 1895, amount expended during fiscal year	21,818.85
July 1, 1895, balance unexpended	2,802.56
July 1, 1895, outstanding liabilities	15.00
July 1, 1895, balance available	2,787.56
Amount (estimated) required for completion of existing project	76,700.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	76,700.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals for extension of breakwater at Dunkirk Harbor, New York, received by Maj. E. H. Ruffner, Corps of Engineers, at Buffalo, N. Y., and opened at 2 p. m. December 10, 1894, in response to advertisement dated November 10, 1894.

[Amount available, $21,475.]

	(1) J. B. Donnelly, Buffalo, N. Y.		(2) Powell & Mitchell, Marquette, Mich.	
	Price per unit.	Amount.	Price per unit.	Amount.
Hemlock timber	$18.00	$2,859.84	$17.20	$2,732.74
White-pine timber	28.00	6,043.30	25.00	5,395.80
Driftbolts	.02	761.46	.02	761.46
Screw bolts, complete	.03	134.28	.02½	111.90
Boat spikes	.04	70.40	.02½	44.00
Button-head driftbolts, complete	.04	43.00	.02	21.50
Filling stone	1.20	3,840.00	1.70	5,440.00
Total	.....	13,752.28	.....	14,507.40

Bid No. 1 is recommended for acceptance.

*Two appropriations. †Allotments.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels for the year ending December 31, 1894.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Steamers	25	4,001	3	1,036	26	4,106	2	690
Sail	10	4,465	.....	.....	10	4,465	.....	.....
Total	35	8,466	3	1,036	36	8,571	2	690

Decrease in tonnage from 1893, 395 tons.
Amount of revenue collected, fiscal year ending June 30, 1894, $277.14.
Value of imports, $2,608.37.
Value of exports, none.
No new lines of transportation established.

Receipts by lake.

	Tons.
Lumber, 6,103,000 feet, B. M	10,680
Grape posts, 18,700	262
Total	10,942

Shipments by lake, none.

N N 4.

IMPROVEMENT OF BUFFALO HARBOR, NEW YORK.

ORIGINAL CONDITION OF THE HARBOR.

In 1818 the mouth of Buffalo Creek was closed by a gravel bar for most of the year. Freshets would at times open a channel, which would be closed later by the lake storms.

PROJECTS OF IMPROVEMENT.

Private enterprise, assisted later by the State of New York, opened the mouth of the creek and protected that opening by parallel piers. These were built in 1820–21—the south pier to a length of about 1,300 feet, the north pier to 1,000 feet.

In 1825 the Erie Canal was completed to Buffalo, and a first appropriation of $15,000 was made by Congress in 1826 "for building a pier and repairing an old one at the mouth of Buffalo Creek." During the ensuing eight years $90,388 were appropriated in five items for "completing the piers (or pier) at Buffalo." By 1833 one pier was 1,790 feet long, the other 1,250; and in 1835 there was a depth of 10 feet in the channel. Various projects were submitted by those in charge or connected with the work between 1830 and 1845. In 1837 a sea wall was proposed, to extend about a mile south of the light-house, at an estimated cost of $40,000. Congress adopted the project; gave $48,000 for it in 1838 and $20,500 for "continuing the work at Buffalo."

Work on the sea wall continued until 1840, at which time it was 3,770 feet long.

Appropriations in 1840, 1852, 1853, and 1855, amounting to $54,801.37, maintained existing works, but nothing new was begun. Total appropriated to this date, $262,895.37.

In 1854 a Board of Engineer Officers prepared projects for detached breakwaters to form an outer harbor, but nothing came from this report.

Meanwhile the city dredged Buffalo Creek for an interior harbor, and extended its area in 1848 by digging the "Blackwell Ship Canal" 200 feet wide and 16 feet deep.

During the war lake commerce increased vastly, and in 1863 the total arrivals and departures of vessels at Buffalo reached the largest figures attained, 16,390.

In 1864 an appropriation of $37,500 was made for "repairs and completion of the sea wall." In 1866 and 1867 the sea wall was carried to its ultimate length of 5,400 feet. No further work has been done on it except slight repairs. The piers were repaired with an allotment of $15,000 made in 1865. An appropriation for the harbor of $131,000, made in 1866 and a second in 1867, of $100,000 caused an examination of the question by a Board of Engineer Officers, which reported in 1868:

(1) To extend slightly and thoroughly repair the north pier.
(2) To repair the south pier.
(3) To extend the south pier 318 feet.
(4) To dredge the channel at its entrance, about 12,000 cubic yards.
(5) To build a detached breakwater, beginning at a point in the prolongation of the south pier and 2,500 feet from the light-house, 4,000 feet southwardly, parallel to the shore.

There were two other items proposed which were, however, not approved by the Chief of Engineers. The project outlined above has been carried out.

Difficulties in construction of the breakwater occurred in 1872 and 1873, and the subject was referred to a Board of Engineer Officers, which met in 1873 and 1874 and recommended a catch-sand pier of piling to the 12-foot curve in the lake, and of crib work thence to a total length of 1,270 feet. The detached breakwater was to be built to a total length of 7,600 feet.

A shore arm, making an angle of 45 degrees with the shore, was proposed, running from the end of the catch-sand pier, and overlapping the south end of the breakwater, leaving a fair-weather opening of 150 feet between the two structures. This project was approved and is in course of construction.

EXISTING AND AUTHORIZED WORKS.

North pier.—The Delaware, Lackawanna and Western Railroad has unauthorized possession of this pier. A license for their occupation of it was revoked by the Secretary of War on February 20, 1891. The matter was placed in the hands of the Department of Justice in order to have the interests of the United States protected. I am not aware that anything has been done as yet, certainly nothing since I have been here on duty.

Boathouse.—Is in fair condition.

South pier.—It was mentioned in former reports that settlement had occurred in places on the channel side of this pier. There are three such places that shall need repairs before long. Otherwise the pier is in good condition.

Breakwater.—This structure has now the full length contemplated of 7,600 feet, under the project of 1874, the modification of the one of 1868. The first crib was sunk in 1869, the last in 1893, nearly a quarter of a century afterwards.

The concrete portion of the breakwater shows no signs of wear or of settlement. Vessels knock off edges in places, and there are a few small holes to be filled ere long.

The timber part is in good condition; minor repairs will maintain it for years.

Minor repairs to replace timbers, stone filling washed out of the pockets, and insecure portions of decking between Stations 20 to 25 were made during July, September, and October, 1894. The material for the repairs was on hand and the cost of labor was $638.

The wrecked portion of the shore arm remains substantially as described in the last report. There is no more sinking noticed, though no critical examination has been made. The needed repairs to this portion must await the report of the Board of Engineer Officers convened, as noticed later, to determine on some method of construction suitable for the area of bad foundation to the south of the breakwater.

Surveys.—The compilation of data for a new edition of the Lake Survey charts, covering the head of the Niagara River and Buffalo lake frontage to Stony Point, was completed in January 1895, and the completed map submitted January 16, 1895.

The field work was about three-fourths completed at the beginning of the fiscal year, covering from the head of the river to the south end of the breakwater.

This was supplemented by a careful survey, extending southward from the breakwater to Stony Point, in July, 1894; and a survey of Niagara River, from its head to Strawberry Island in December 1894. Great care was taken to locate the sounding accurately and to collect all of the data for a map that may be of value in the future to detect changes in the depths in the harbor and river.

Summary of field work on surveys.

Angles read by transit	3,261
Verniers read	7,096
Buoys placed to mark sounding lines	750
Soundings taken	25,184

In accordance with the act of Congress, dated August 17, 1894, providing for "a survey and plan for extending the outer breakwater from a point at or near the present outer breakwater southeasterly to a point at or near Stony Point," a series of test borings was made along the line of the breakwater shore arm and along the line of the breakwater extended southerly to Stony Point.

The borings were made through the ice; were located 500 feet apart, and the locations well determined by transit angles and tape measurements. Samples of the kinds and thicknesses of the various strata of material were secured at each boring.

The borings were made under contract, both the auger and water-jet method being used; and with facility, owing to the soft sand and clay strata met with.

The borings were begun on January 25, and completed on February 20, 1895.

Summary of field work on test borings.

Number of test borings made	39
Total number of linear feet of borings	1,271.9
Average depth, linear feet	32.6
Greatest depth, linear feet	50
Cost, at 74 cents per linear foot	$941.21

Maps showing the location of the borings and cross sections of the lake bottom to rock were prepared and submitted to the Board of Engineers, which convened at Buffalo, N. Y., pursuant to Special Orders, No. 13, headquarters Corps of Engineers, U. S. A., series of

1895, on May 27, 1895, to devise plans for breakwater construction in conformity with the above mentioned act of Congress.

Abstract of proposals for test borings on the line of breakwater, Buffalo Harbor, New York, opened at 2 p. m. December 27, 1894, by Maj. E. H. Ruffner, Corps of Engineers, in response to advertisement dated November 27, 1894.

[Allotment, $5,000.]

No.	Name and address of bidder.	Price per linear foot.	Remarks.
1	John H. Stock, Forks, Erie County, N. Y	$2.50	Only two proposals.
2	Logie & Leh, Buffalo, N. Y	4.30	Certificate not filled out.
3	William B. Wilson, Buffalo, N. Y	2.25	
4	Wm. S. Bartlemes and W. C. Hiam, Buffalo, N. Y	.74	Recommended for acceptance.

In compliance with the request of the Western New York and Pennsylvania Railroad Company, owners of a large frontage on the outer harbor, the Secretary of War established harbor lines on December 21, 1894, for the outer harbor.

Under date of January 21, 1895, the Secretary of War extended the pierhead line, established July 23, 1894, for Squaw Island, Niagara River, New York, southward to a point 50 feet outside of the river face of the trunk-sewer outlet, about 505 feet south of the foot of Ferry street, Buffalo, N. Y.

Money statement.

July 1, 1894, balance unexpended	$74,266.73
Amount appropriated by act of August 17, 1894	70,000.00
	144,266.73
June 30, 1895, amount expended during fiscal year	9,779.29
July 1, 1895, balance unexpended	134,487.44
July 1, 1895, outstanding liabilities	200.00
July 1, 1895, balance available	134,287.44
Amount (estimated) required for completion of existing project	400,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	335,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

SURVEY AND PLAN FOR EXTENDING THE PRESENT OUTER BREAKWATER AT BUFFALO, N. Y., SOUTHEASTERLY TO STONY POINT.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., February 19, 1895.

GENERAL: As required by you August 29, 1894, I submit the following plan and estimate for extending the breakwater at Buffalo from the southerly end to Stony Point, as provided by river and harbor act of August 17, 1894:

The surveys necessary are finished. The ruling result is the exceedingly bad foundation found over the whole area from the point of beginning up to the close proximity of Stony Point. Forty borings have been taken to the rock and there has been no spot or area differing sufficiently from the rest to give one the hope that some error was made through wrong selection of lines or points for examination.

The conclusion is most positive that cribs can not be safely put on any portion of this area.

If anything is to be built it must be as light and stable as possible, resting on a broad foundation. I have designed a structure of stone and concrete, built on a mattress of green trees, 6 inches to 1 foot ends, laid in two cross layers, wired together, and weighted by the usual foundation stone of our works. This mat is at a minimum width of 60 feet for 30 feet depth, but for less depths can hardly be reduced much, as economy can be got rather by cutting off some of the structure above the bottom courses. The mat is intended to be both strong and stiff, and at the same time somewhat yielding, to accommodate itself to the inequalities of the lake bed. On this are to be placed alternate mattresses of similar character, 30 feet wide, and layers, 2 feet, of sinking and holding stone, until a depth of 17 feet is reached. Heavy riprap, the heavier the better, is now to be placed over the whole, and to fill out the slopes, to cover the mat ends well, and to raise the structure to 15 feet depth. Then there shall be placed 3 feet foundation stone, smaller, for a bed for the concrete blocks above. These are, to begin with, 22 feet in length, laid crosswise, and reduce in length 2 feet each until the desired height be reached. These blocks are to be deposited while plastic, and set while adjusting themselves to what they rest upon. In any one year I would not go further than to lay the main foundation and one layer of concrete blocks, and after allowing a year for settlement would lay one or more courses, as might seem advisable at that time.

A general estimate for this structure is as follows per running yard:

55 cubic yards of rock, at $1.25 per cubic yard	$68.75
29 cubic yards of mats, at $2 per cubic yard	58.00
53 cubic yards of concrete, at $7 per cubic yard	371.00
Total per running yard	497.75
Total per running foot	166.00

There are many advantages of such a structure, if it can be built as above. It will be permanent; can not rot; can easily be repaired for settlement or if blocks are carried away. When built there is no need to be anticipating a renewal in the not distant future. Hence, with a large initial cost there may be economy in the end. Vessels can not lie alongside—this would not be accepted as in its favor by navigators. The estimate is liberal—quite so; and it might be reduced if a large amount were contracted for at one time.

I am not at all certain that even this structure is light enough to be built with safety on the area in question. Piles can be used for the extension of the sand-catch pier, and near Stony Point; nowhere else.

Location of any new works.—The line over which it is required to contemplate the building of an extension of the Buffalo Breakwater to the south is some 12,500 feet long.

The lake frontage to this possible harbor is owned principally by the Lehigh Valley Railroad and the Buffalo Creek Railroad, the latter owning some 3,200 feet front, lying partly north and partly south of the sand-catch pier.

The Lehigh Valley Railroad exhibits a remarkable degree of skill and business foresight in having planned out and constructed in a most masterly manner a port of its own, with every facility for carrying on an immense lake business through its steamers, on its own wharves and warehouses. It has probably expended at this point more money in this improvement than the United States has at Buffalo during the

past seventy years. It is prepared to extend its plans by cutting a canal into the lake from its interior canals, whenever a breakwater will allow this to be done. Owning, as it does, no less than 6,200 feet of frontage, half of the whole, it is the most to be concerned in the proposed plans. I have been in close touch with many of its officers, and think I can speak for them. The suggested and outlined breakwater, 2,000 feet long, opposite the outlined piers, and canal entrance shown gives the main idea of the wishes of this company. To the north of this point neither of the companies, who are the sole owners of frontage, ask for any breakwater protection for the present to the south of the sand-catch pier and the shore arm.

Every owner of frontage on the outer harbor—and I have reason to speak with authority on this subject—expects to ask that the project of 1874 be carried out and the harbor completed as planned, in order to allow them to enjoy its benefits.

They claim, and with reason, that the only way in which they can see an early possibility of building piers in the outer harbor is that it shall be thoroughly protected as soon as possible. They claim, and with justice, that the completion of this harbor need not in any way prejudice the building of similar works at Stony Point or near there, and that if they must wait the carrying out of some grand, general project, they are hardly likely to see in any definite time any good to come from the breakwater already built in a lifetime.

Inasmuch as the project of 1874 must be changed in the mode of construction in any event, it is possible that the experience gained by trying to build something that will stand will be of more value in this vicinity than anywhere else. I have therefore planned to extend the sand catch by pile work some 525 feet to 18 feet of water; then, using the general form of mat foundation structure already described, go to the end of the work of 1893. This will be, in all, 2,750 feet. On the outside of the old work there shall be only a 30-foot mat and riprap only on the outside, and concrete blocks on it and the wreck. It is doubtful if this can be done at any less cost than the full cross section as planned. The pile pier may cost $25 a running foot.

Lastly, to accommodate those holding the southern end of the frontage in question, some 3,000 feet, as measured on the Breakwater-Stony Point line, there might be built a breakwater 1,850 feet long from Stony Point northwardly, as shown, of which the first 750 feet may be of piling, to 18 feet deep; then mat and concrete work. The first might average $25 per foot. Such a harbor would furnish a good refuge from southwest gales and cover a good front, with deep water close to shore.

If in time there arose need for more protection, and the works as built stood, this and the breakwater opposite the Lehigh Valley Railroad Canal could be connected entirely or with an overlap. The gap, as planned, is some 2,250 feet.

The general estimate, with order of building, is as follows:

Extension of the sand-catch pier to 18 feet depth, 525 feet pile work, at $25.	$13,125
Completion and rebuilding of the shore arm, 2,750 feet mat work, at $166.	456,500
Breakwater opposite the Lehigh Valley Railroad entrance, 2,000 feet, at $166	332,000
Pile and mat pier at Stony Point, 1,850 feet, at $25 and $166.....	182,600
Total for projected work.....	984,225
Should there be built later a connection between the last two, it would cost for the 2,250 feet additional.....	373,500
Total for all suggested.....	1,357,725

It is to be understood that I do not assert that the method of construction is certainly secure, or that it can be built, or that anything can certainly be built on the mud at the south end of the area in question—in fact, I very much doubt if the consistency is enough to support any structure within reasonable cost—but I do think we can try it first at the northern end to advantage in repair and extension of the shore arm. There is an interval of 6,500 feet north from the breakwater proposed, opposite the Lehigh Valley Canal entrance, which is not provided for at all. There is no commercial necessity for any works over this stretch. As already said, the frontage is all owned by the Buffalo Creek Company, which would probably utilize its frontage within the outer harbor, preferably, and by the Lehigh Valley Railroad, which certainly would not think of building or of leasing so long as its interior dock space is not fully occupied, and the half of this is as yet untouched. It is most certain that there can be no thought of using the frontage now in question until all of the other projects suggested have been fully occupied and a demand arises for still further extension.

In that remote contingency there is nothing proposed by me which would interfere in the slightest degree with extensions to the northward of the works proposed in the vicinity and north of Stony Point.

But it is indisputable that the one thing that can retard the immediate utilization of the harbor facilities of Buffalo, and put off into an indefinite future the securing of more dock room, is the pushing of the idea that the next step in breakwater building is an extension to the southward from the present breakwater.

Such extension is the only proposition not of advantage at the present time, commercially speaking.

There are other ways of securing immediate and valuable extension of dock room for Buffalo that are not touched upon by me, because there seems to be the intention to confine projects for coming work to the area in question—not to consider all that may be for the benefit of the city and its commercial interests. These other plans are to be brought to the notice of Congress by parties interested. A blue print* of plan accompanies and one* of cross sections of the borings follows.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Division Engineer of the Northeast.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, February 23, 1895.

Respectfully forwarded to the Chief of Engineers, U. S. Army. I recommend that this project, together with the whole subject of the further improvement of Buffalo Harbor, be referred for investigation and report to a Board of Engineer Officers.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

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* Not printed.

REPORT OF BOARD OF ENGINEERS.

ARMY BUILDING,
New York City, July 1, 1895.

GENERAL: The Board of Engineer Officers appointed by Special Orders, No. 13, headquarters Corps of Engineers, April 23, 1895, to consider and report upon the plan and estimate submitted by Maj. Ernest H. Ruffner, Corps of Engineers, for extending the outer breakwater at Buffalo, N. Y., has performed the duty assigned to it and has now the honor to submit the following report:

The Board assembled at Buffalo on May 27, 1895, and on that date gave a public hearing to parties interested in the subject under consideration. A summary of this hearing is embodied in the record of proceedings of the Board.

On May 28, 1895, the Board, in company with Major Ruffner, the district officer, made an inspection of Buffalo Harbor, returning in the afternoon. At 4 p. m. of the same day and on May 29, 1895, the Board gave additional public hearings to interested parties, a summary of which is also contained in the proceedings of the Board.

At the close of the public hearing on May 29, 1895, the Board, after some time spent in carefully considering the subject-matter of its report, adjourned, and reassembled in New York City on July 1, 1895, in obedience to Department orders.

The harbor at Buffalo, N. Y., is entirely artificial. Naturally there existed no safe place in this vicinity where vessels could lie, or could receive and discharge their cargoes, except the area within the mouth of Buffalo Creek. The mouth of this creek was generally closed to navigation, even to the small vessels of the time, by a gravel bar. Freshets would occasionally open the channel through the bar, which would soon be closed up again by the waves of the lake.

The earliest work of improvement done at this place was by private enterprise, assisted subsequently by the State of New York. In this way parallel jetties were built at the mouth of the creek, which concentrated the current and practically removed the bar. In 1826 the work of improving this place was first considered by the United States, and in the years immediately following the jetties were rebuilt and extended by the General Government, which has ever since retained charge of it.

The width between the jetties at the outer extremity is only about 200 feet, and through this narrow opening all the lake commerce of Buffalo must pass, for all wharves, docks, and warehouses lie within the mouth of the creek. The need of a sheltered area in the lake beyond the mouth of the creek was early recognized. In 1868 a Board of Engineer Officers recommended the construction of an outer breakwater in the lake, about 2,500 feet in advance of the light-house, on the extremity of the south jetty, and extending southward generally parallel to the lake shore for a distance of 4,000 feet. This work was built and has since been extended to a length of about 8,000 feet in all. Owing to its great distance from the shore and to the fact that it extends in a southerly direction, from whence come the most violent storms and heaviest seas, it has not sheltered the area behind it to an extent sufficient to subserve the needs of commerce. As the result, no wharves or docks have been constructed behind it along the lake shore, and vessels do not use the space behind it as an anchorage if they can conveniently avoid it. Now, a project has been submitted by Major Ruffner, district engineer, in obedience to an act of Congress calling for "a plan and estimate for

extending the outer breakwater from a point at or near the present outer breakwater southeasterly to a point at or near Stony Point."

This project provides:

First. For the construction of a detached piece of breakwater, about 2,000 feet in length, situated on the general line from the present breakwater to Stony Point, and so placed as to cover (in part at least) that portion of the lake front owned by the Lehigh Valley Railroad Company. The object of this work is to permit the construction, under the shelter which it will afford, of a jettied channel from deep water in the lake to the extensive system of interior wharves which this railroad company has erected, and which are now only to be reached by the narrow channel of Buffalo Creek. It has been promised that this jettied channel shall be built and maintained by the railroad company.

Second. It is proposed to carry out the provisions of the project of 1874 by completing, at an estimated cost of $469,625, the shore arm then recommended.

Third. It is proposed to construct a section of breakwater 1,850 feet long, extending from Stony Point northward toward the present breakwater.

Fourth. Finally it is suggested that if in time need arises for more protection, this section and the piece opposite the Lehigh Valley property could be united by the construction of about 2,250 feet more of breakwater.

The execution of this project would require the construction of 6,100 linear feet of breakwater, of which about 750 feet would be a structure of piles, and comparatively inexpensive. Its cost (not including the shore arm) is estimated at $888,100. When thus completed there would be two similar exterior harbors at Buffalo, about 6,000 feet apart, and having so little logical relation to each other that the removal of the shore arm separating them would probably be demanded.

The Board does not consider that this plan fulfills the requirement of the act of Congress already quoted, nor does it adequately and economically meet the needs of the commerce of the port of Buffalo.

The Board holds that the shore arm should be omitted, and that the breakwater should be extended all the way to Stony Point. The apparently large sheltered area thus secured is no greater than the future commerce of Buffalo will require and may rightfully demand.

Buffalo is one of the great ports of the United States. Though closed by ice to navigation for nearly four months out of the year, its arriving tonnage during the remaining eight months is, according to the reports of the Chief of Engineers, equal to three-fifths of that arriving in the harbor of New York in an entire year, and the number of vessels that come here during the season of navigation is equal to four-fifths of the number arriving at New York in an entire year. Yet the proposed sheltered anchorage for this great port is less than 1,000 acres, reckoning that portion only which lies without the 12-foot contour. For the purpose of comparison, it may be stated that this area is about equal to that portion of the North River which lies between the Battery and the Christopher Street Ferry.

In view of the foregoing, the Board does not think that any reduction of this area would be advisable, forming, as it does, not only an important local harbor, but also the only harbor of refuge for shipping on route to and from the great ports on the Niagara River below.

The reasons generally advanced by the parties interested who favored separating the harbor into two parts by the construction of this shore arm have been that they desire to avail themselves at once of the shelter which would then be afforded, and they fear that if, the larger

project is adopted, the work will be many years in the process of construction, and that adequate shelter will not result until it is completed. The Board does not share in the fear thus expressed. It sees no engineering reason why the entire work might not be completed in two or three seasons, if the funds to pay for it were forthcoming, and it believes that Congress will deal no less liberally with this great harbor than it has with other similar works of national importance for which continuing contracts have been provided.

It remains, then, for the Board to consider the proper mode of constructing this extension of the breakwater from its southern terminus to Stony Point. The borings which have been taken show that the general depth of the water along the line proposed is about 28 feet, and that the bottom consists generally of soft clay, in a layer about 25 feet in thicknesss, resting upon hard gravel or rock.

The style of construction proposed by the district engineer gives a structure as light as possible, resting upon a broad foundation, which he hopes (but does not feel sure) will be supported by the mud. The Board is reluctant to trust such a foundation. Material of this kind when compelled to support a heavy load does not yield by compression, whereby its density is increased and its power to support a load augmented so that settlement always tends to bring about a sort of equilibrium, but it yields rather as would any other semifluid, by flowing outward from beneath the foundation until finally the structure forces its way to the better material below, or until the displaced material rises up at the sides sufficiently to counterbalance the weight to be supported. Therefore, in such a case we can not hope for equal settlement. A structure thus supported generally settles unequally and is liable to tip and fall over; and no one can tell when settlement has reached its limit. The fact that such a structure has remained without settlement for a considerable length of time gives no guarantee that it will continue to do so. If the bad material were very deep, or, in other words, if the hard material were at an unreasonable distance below, the Board might feel itself compelled to consider some form of construction which would float upon the mud. But fortunately the hard material is found at a depth of about 35 feet below the surface of the mud.

In that portion of the breakwater already constructed a similar condition was found to prevail over a part of its length. The depth, however, to the hard material was not quite as great, being only about 20 feet. The difficulty was here overcome by digging a trench down to the hard material. The trench had a width of 50 feet at the bottom, and side slopes as steep as they would stand, which was found to be about 1 on 1. This trench was immediately filled with coarse gravel, and upon a foundation thus prepared the breakwater was erected, and it has remained without appreciable settlement ever since.

The contractor who dredged the trench just described came before the Board by request, and in reply to questions stated that no difficulty whatever was encountered in preparing this foundation in 20 feet of mud, that the sides of the cut stood very well, and that the amount of material that slid in was not sufficient to give any special trouble. He was shown the material taken from the borings along the proposed extension, and pronounced it to be identical in character with that which he had dredged up. As a practical dredge man with large experience he would anticipate no special difficulty in dredging a cut 35 feet deep in 28 feet of water through similar material. He also stated that gravel suitable for filling the trench was to be had in quantities in excess of requirements at points conveniently accessible to the work.

Where a reliable foundation can be had with certainty in this way, the Board feels that it can not recommend the construction of any work on an uncertain foundation.

The next question to be considered is the kind of structure which shall be built upon the foundation thus prepared. In the work already done upon the breakwater, this consists of timber cribs filled with small stone for the submerged portion, and capped with a timber and stone or a concrete superstructure above the water. The vertical sides cause such a construction to offer but little resistance to waves when in deep water, and also make it a convenient mooring to which vessels so desiring may tie up for shelter. The chief objection, which is specially applicable to the substructure, is its liability to injuries and the very great difficulty of repairing it.

There is now completed nearly 8,000 feet of work of this kind; this length is thought to be sufficient for the mooring of vessels, permitting for the remainder a style of construction similar to that adopted for the great breakwaters on the Atlantic coast. It is proposed, therefore, to build up a structure of small riprap stone to a height of about 12 feet below the mean lake level, and upon this to build with large stone from 4 to 10 tons in weight up to a height of about 10 feet above that level. These large stones should be deposited irregularly in a wall along the axial line of the proposed structure, and with side slopes as steep as can conveniently be made to stand. It is expected that the action of storm waves will reduce the height and will flatten the slopes down to a position of ultimate stability. The structure will have to be recapped probably more than once with large stone of the kind described until it remains permanently at a height about 10 feet above the water at ordinary lake level. The advantages of a breakwater of this kind are that nothing placed in it is lost; that no conceivable injury to it can do more than reduce its height somewhat; that it must always be left in the best possible condition for repair; and that a time must certainly come when repairs of any kind will cease to be necessary.

For the convenience of commerce and to prevent the water within the sheltered area from becoming stagnant and offensive, it is recommended that a proper number of openings, as indicated upon the chart, be left in the new work between the end of the present breakwater and Stony Point. The width of these openings should be about 350 feet; and the plan of the breakwater be such as to prevent as far as possible the waves from entering the harbor. At the ends of the sections particularly large selected stones should be used, in order that they may not move down and obstruct the entrances after having been once put in place.

The accompanying drawing is intended to show the location and the average cross section of the structure proposed by the Board.

The following is the estimated cost of the work:

To excavate a trench 35 feet in depth and having a bottom width of 50 feet will require the removal of 110 cubic yards per running foot, measured in place. It is estimated this will cost 25 cents per cubic yard. To fill this trench with gravel will require 110 cubic yards of gravel per running foot, estimated to cost 25 cents per cubic yard. The filling of small stone will have a width at base of 82 feet and a height of 16 feet, and side slopes of 2 on 3. This will require 35 cubic yards per running foot and is estimated to cost $1 per cubic yard. For the large stones of from 4 to 10 tons weight there will be required 27 cubic yards per running foot,which is estimated to cost $3 per cubic yard. This price is based upon the investigations made by the recorder by direction of the Board. It was ascertained that suitable stone could undoubtedly

be obtained at the cost of $4 a cubic yard of solid stone in the breakwater. A reasonable allowance for the volume of the voids in the structure would permit the cost per yard of the entire volume to be reduced to $3.

SUMMARY.

110 cubic yards of dredging, at 25 cents	$27.50	
110 cubic yards of gravel filling, at 25 cents	27.50	
Total for repairing the foundation		$55.00
35 cubic yards of small stone, at $1	35.00	
27 cubic yards of large stone, at $3	81.00	
Total for structure		116.00
Total for the finished work, per running foot		171.00
11,500 running feet, at $171 per foot		1,966,500.00

To which about 10 per cent should be added for engineering expenses and contingencies not included in the foregoing. This brings the estimated cost of the work to $2,200,000.

It is worthy of note that the cost per running foot compares very favorably with that of the crib structure heretofore built at this place.

Respectfully submitted.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.
H. M. ADAMS,
Major, Corps of Engineers.
DAN C. KINGMAN,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
July 25, 1895.

The report of July 1, 1895, of a Board of Engineers containing a project for the extension and improvement of the harbor at Buffalo, N. Y., is respectfully submitted to the Secretary of War and recommended for approval, subject to such changes in details by the Chief of Engineers as may be found to be expedient or necessary during construction.

W. P. CRAIGHILL,
Brig. Gen., Chief of Engineers.

[Second indorsement.]

WAR DEPARTMENT, *August 1, 1895.*

Appproved as recommended by the Chief of Engineers.
By order of the Secretary of War:

JOHN TWEEDALE, *Chief Clerk.*

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., June 21, 1895.

I have the honor to submit the following report of the investigation which I have made with a view to ascertaining the probable cost of stone suitable for use in the extension of the Buffalo Breakwater.

My opinion was that the most favorable place to obtain it was Kelly Island, near the western end of Lake Erie. I accordingly visited Cleveland, Ohio, and had an interview with Mr. Gowen, the general manager of the Kelly Island Lime and Transportation Company. From him I ascertained that this company had resulted from a combination of all the small companies on the island; that it now owns or controls all of the available quarries. The company possesses ample wharves for shipment of its product and abundant facilities for getting it out.

The Kelly Island stone is well known to the Government; it was used in the construction of both of the locks of the Sault Ste. Marie, and appears to possess the requisite hardness and durability.

From samples that I saw, it appears to be a limestone of light-gray color and a decided crystalline structure. It is said to be nearly pure calcium carbonate, containing only about 3 per cent of impurities—mainly clay. The upper layers in the quarry are very thin, and this material is gotten out for sale to the blast furnaces for use as a flux. The lower layer, from which the stone would be furnished for Buffalo, is said to be 12 feet in thickness and without seams. The stone weighs $2\frac{1}{4}$ tons to the cubic yard. Channeling machines are used in the quarry, and blocks can be gotten out of any size desired. The derricks now at the work do not handle stone of over 6 tons weight, but larger derricks capable of handling 10 tons and upward could easily be erected both in the quarries and on the wharves. The company also owns and operates large quarries at Marblehead, on the mainland, but they would prefer to ship the stone to Buffalo from Kelly Island. The present annual shipments of the company amount to about 700,000 tons of stone of all kinds. When it came to a question of cost, the manager thought that large stone, of 10 tons weight and upward, could be delivered in the breakwater at Buffalo for about 30 cents a cubic foot, or $8.10 a cubic yard. Upon my expressing some surprise he gradually came down in price to 25 cents and then to 20 cents a cubic foot. This last would be $5.40 a cubic yard. I then requested him to make an analysis of this cost, and he figured as follows:

For the cost of stone loaded on the vessel at Kelly Island, 12 cents a cubic foot, or $3.24 a cubic yard; for the cost of transportation to Buffalo, 70 cents a cubic yard; for unloading the stone into the breakwater, 25 cents a cubic yard; in all, $4.19 a cubic yard.

After further discussion, the manager finally stated that he thought that his company would be willing to take a large contract, say for several hundred thousand yards of this stone, at $4 a cubic yard, in place in the breakwater. But I could not induce him to say that he thought it possible to do the work for any less. Of course it was understood by the manager that I was simply endeavoring to obtain figures for the purpose of estimate.

In regard to small stone—that is to say, stone of from 25 to 125 pounds in weight—he thought that it could be furnished from these quarries in any amount desired and delivered in the breakwater at Buffalo, N. Y., at from $2 to $2.50 a cubic yard. This estimate is excessive, as the small stone can be obtained much cheaper elsewhere.

There is other stone in Ohio, notably at Berea, where it is extensively quarried on a very large scale, but the stone is a sandstone, and, in my judgment, does not possess the hardness and durable qualities requisite for our purposes; moreover, it would have to be brought, part way at least, by rail.

Returning to Buffalo, I made extensive inquiries among large dealers in stone, and found that there was a certain native rock not far from

Buffalo which could be obtained, in one case at least, for about $1 a cubic yard at the quarries. The stone is well known and can be seen in the old stone breakwater. It is decidedly a second-class stone, but the great and insurmountable objection to it is that the layers are very thin, not much over a foot in thickness, and in order to get pieces of the weight desired they would have to be so long and wide that they would resemble great flagging stones and would be entirely unsuitable. I did not consider this stone any further.

A good deal of granite is brought to Buffalo for building purposes from the quarries in New Hampshire and Massachusetts. It can be obtained in pieces of any size that a car can carry, but would cost in large quantities, delivered in the breakwater, about 50 cents a cubic foot, or $13.50 a cubic yard. The greater part of this cost is for railroad transportation.

Stone was formerly quarried for building purposes at Lockport, N. Y. It was a limestone and is found in rather thin layers. It was formerly used in certain structures on the Erie Canal, but gave bad results as to durability, and has been, I was informed, very largely replaced. It is not worth considering for our purpose.

Eastward of Lockport and along the same ridge, parallel to the Erie Canal, are found quarries of sandstone known to the trade as Medina sandstone. I visited Albion, N. Y., where some of the largest and best quarries are being worked. The stone is a fine-grained siliceous sandstone, sometimes verging on quartzite. Its color varies from gray to red, and it shows a decided conchoidal fracture. It is quite extensively used for paving, flagging, curbing, and for window sills, lintels, etc. The thickest layers that I saw in the quarries I visited were from 4 to 6 feet. The total thickness of stone worked is about 12 feet, and about 8 or 10 feet of stripping has to be done to uncover it.

The channeling machines are not used in these quarries. The stone is broken out by simultaneous blasts of very small charges of black powder in plugged holes. The quarry is less than a quarter of a mile from the Erie Canal and the stone is all shipped by water. The derricks at this quarry can handle blocks of over 10 tons in weight. The cost of transporting the stone by water to Buffalo is said to be about 75 cents a cubic yard. In large quantities, giving steady employment to boats, it might be done for a little less. The manager stated that he would furnish small stone delivered on the boat in Buffalo Harbor for $1 a cubic yard. He would furnish larger stone, that is to say, a kind of quarry waste of irregular-shaped pieces, weighing from 1,000 to 3,000 pounds, for $1.50 a cubic yard loaded on the boats. He would furnish still larger pieces of 3 or 4 tons in weight for $3 a cubic yard on the boats; but he would not undertake to furnish stone of 10 tons weight, that is to say, blocks of good symmetrical form where the smallest dimension was not less than one-third the largest dimension, for less than $4 a cubic yard on the boats. This would make this stone cost not less than $5 a cubic yard in the break-water. He stated that the price, $4, would do little more than cover the labor required in the quarry. He thought that his quarry could furnish about 150 boat loads in the course of a season. This would be a little less than 20,000 yards. He thought that it would take the combined effort of all the quarries on the Medina Ridge a great many years to furnish the amount of stone desired.

It seems to me, therefore, as the result of this investigation, that Kelly Island furnishes the most promising locality from whence to obtain the large stone, and that $4 a cubic yard in place is as low an estimate of cost as the Board can safely assume. It seems to me,

further, that the small stone required can best be obtained from the Medina quarries or other points in the vicinity of Buffalo, and that $1 a cubic yard is as low a price as the Board can safely assume for it.

I ascertained that stone has actually been furnished in the Buffalo Breakwater at this price.

Respectfully submitted.

DAN C. KINGMAN,
Captain of Engineers.

THE BOARD OF ENGINEER OFFICERS ON BUFFALO HARBOR.

Breakwater construction.—Begun in 1869; continued as shown in table:

Year.	Length of crib sunk.	Foundation finished.	Superstructure laid.	Total completed length.
	Feet.	*Feet.*	*Feet.*	*Feet.*
1869	150	150	.....	.....
1870	800	950	400	400
1871	750	1,711	783	1,183
1872	425	2,136	870	1,853
1873	263	2,399	231	2,048
1874	100	2,499	415	2,499
1875	.....	2,515	.....	2,515
1876	360	2,765	200	2,715
1877	150	2,915	200	2,924
1878	150	3,074	.....	.....
1879	.....	.....	150	3,976
1880	350	3,436	350	3,426
1881	500	3,926	.....	.....
	200	4,126	.....	.....
1882	300	4,437	504	4,437
			504	
1883	450	4,891	454	4,891
1884	800	5,696.9	806.9	5,696.9
1885	450	6,146.9	200	5,896.9
	200	6,349.8	452.9	6,349.8
1891	450	6,802.4	452.6	6,802.4
1893	800	7,608.7	806.3	7,608.7

Statement of appropriations and allotments made for improving harbor at Buffalo, N. Y., from May 26, 1826, to the present time.

May 26, 1826	$15,000.00	June 10, 1872	‡$98,485.04
May 19, 1828	34,206.00	March 3, 1873	75,000.00
April, 23, 1830	15,488.00	February 23, 1874	20,000.00
March 2, 1831	12,900.00	June 23, 1874	75,000.00
July 3, 1832	10,300.00	March 3, 1875	100,000.00
March 2, 1833	31,700.00	August 4, 1877	85,000.00
June 28, 1834	20,000.00	June 18, 1878	80,000.00
July 7, 1838	*68,500.00	March 3, 1879	100,000.00
June 11, 1844	40,000.00	June 14, 1880	90,000.00
August 30, 1852	14,000.00	March 3, 1881	90,000.00
March 3, 1853	349.05	August 2, 1882	125,000.00
March 2, 1855	452.32	July 5, 1884	100,000.00
June 28, 1864	†15,000.00	August 5, 1886	112,500.00
July 2, 1864	37,500.00	August 11, 1888	225,000.00
June 23, 1866	131,000.00	September 19, 1890	300,000.00
March 2, 1867	100,000.00	July 13, 1892	300,000.00
April 10, 1869	†89,100.00	August 17, 1894	70,000.00
July 10, 1870	80,000.00		
March 3, 1871	100,000.00	Total	2,861,480.41

* Two appropriations.
† Allotment from general bill.
‡ Includes $23,485.04 which had reverted to Treasury and was reappropriated.

COMMERCIAL STATISTICS OF BUFFALO HARBOR, NEW YORK.

[Compiled from the report of the Buffalo Merchants' Exchange for the year 1894.]

Arrivals and departures of vessels for the year ending December 31, 1894.

	Home ports.		Foreign ports.		Total.	
	No.	Tons.	No.	Tons.	No.	Tons.
Arrivals	3,932	4,075,016	863	248,521	4,795	4,323,537
Departures	4,075	4,318,669	794	147,696	4,869	4,466,365

	Vessels.	Tonnage.
Total arrivals and departures	9,664	8,789,902
Decrease in 1894:		
Arriving	520	435,480
Departing	469	269,117
Total	989	704,597
Enrolled at port of Buffalo, N. Y., 1894	358	177,708.85

Amount of revenue collected at the port of Buffalo in 1894, $473,830.50; decrease in 1894, $280,454.94

Receipts by lake for the years 1890, 1891, 1892, 1893, and 1894.

Articles.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Barley	127,977	104,955	110,423	138,995	207,002
Corn	1,279,963	858,876	938,956	1,175,659	843,277
Flour	612,067	693,147	955,120	1,035,085	1,125,876
Oats	221,772	199,266	264,004	331,202	248,964
Rye	35,886	156,895	36,863	18,049	14,033
Wheat	746,059	2,308,379	2,347,307	2,047,313	1,505,824
Flaxseed	75,093	177,030	163,337	136,542	41,440
Feed	76,853	89,119	110,671	122,300	133,250
Malt	11,585	11,919	8,502	9,391	13,429
Oatmeal	1,527	890	3,869	.....	3,265
Pease	1,969	6,575	2,015	2,030	3,519
Oilcake	38,333	30,653	41,952	20,951	16,385
Seeds	3,266	3,375	5,599	6,397	2,384
Lumber	502,835	459,776	523,215	501,814	419,170
Timber	471,450	857,170	630,000	336,000	228,900
Laths	8,562	1,378	3,363	3,813	1,952
Shingles	8,820	5,389	5,060	6,097	12,613
Posts	1,200	2,249	700	168	553
Ties	14,783	17,893	23,438	18,975	14,709
Staves	388	170	.....	.....	340
Stave bolts	10,496	14,608	11,840	10,128	7,992
Copper	39,636	50,934	34,860	64,930	93,658
Copper matte	40,000	26,420	16,950	13,770	3,752
Iron ore	551,940	421,890	224,720	243,442	306,670
Iron, pig	33,910	30,730	46,160	33,950	26,324
Lead, pigs	23,350	27,938	25,309	34,488	21,855
Spelter plates	6,265	5,894	6,202	9,902	12,400
Glucose	1,179	12,600	38,310	43,262	73,012
Lard	65,010	18,123	20,784	15,559	61,501
Pork	5,590	4,821	3,440	1,354	3,666
Wool	3,505	13,841	6,954	2,390	7,315
Total	5,023,269	6,614,903	6,609,923	6,383,956	5,457,030

Receipts by lake during the year ending December 31, 1894.

Articles.	Tons.	Percentages.
Grain, flour, and malt	3,958,405	72.54
Lumber	686,229	12.58
Copper, iron, zinc, and lead	464,659	8.51
Other receipts	347,737	6.37
Total	5,457,030	100

Shipments by lake from Buffalo Harbor for the years 1890, 1891, 1892, 1893, and 1894.

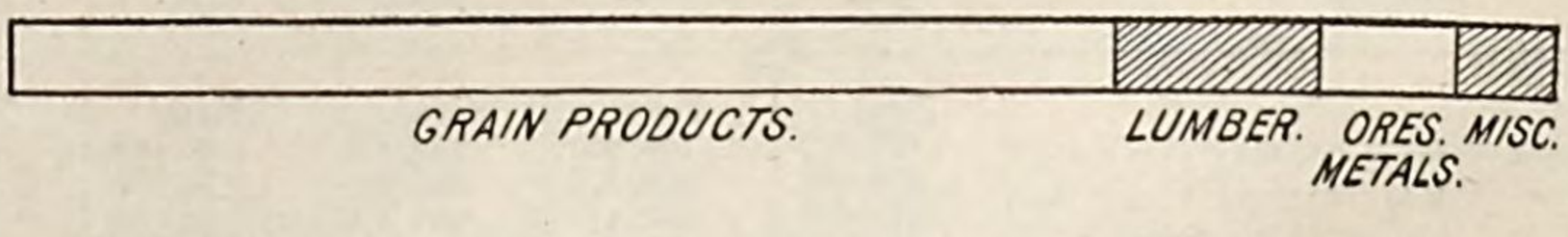
Articles.	1890.	1891.	1892.	1893.	1894.
Coal	2,157,810	2,365,895	2,852,330	2,703,673	2,485,255
Cement and plaster	91,146	81,578	88,936	65,156	71,413
Salt	25,260	24,680	21,688	37,361	104,845
Railroad iron	34,287	9,055	13,235	7,317	980
Sugar	.....	.....	.....	119,426	196,977
Total	2,308,503	2,481,208	2,976,183	2,932,939	2,859,470

Shipments by lake during the year ending December 31, 1894.

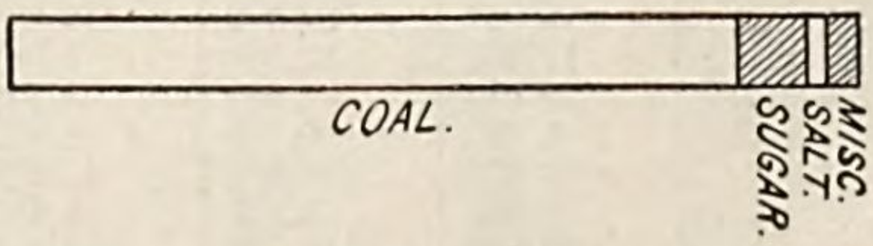
Articles.	Tons.	Percentages.
Coal	2,485,255	86.91
Cement and plaster	71,413	2.50
Salt	104,845	3.66
Railroad iron	980	.04
Sugar	196,977	6.89
Total	2,859,470	100

Receipts, 1894.

[1 inch = 1,500,000 tons.]



Shipments, 1894.



N N 5.

IMPROVEMENT OF TONAWANDA HARBOR AND NIAGARA RIVER, NEW YORK.

Object.—To provide a navigable channel from the entrance to the Niagara River at Lake Erie to the north end of Tonawanda Harbor, and to dredge that harbor to a depth permitting its use by vessels with 16-foot draft.

Project.—To remove obstructions so as to make a channel 400 feet wide and 18 feet deep, which includes work at the following places:

1. On the reef known as "Horseshoe Reef" at the entrance of Niagara River.
2. On the shoal place at the head of Strawberry Island.
3. A few shoal places abreast of the lower end of Rattlesnake Island.
4. The full width of the river between Tonawanda Island and the mainland along the entire front of Tonawanda.

This project was approved in 1888.

Operations during the fiscal year.—Under contracts with Hingston & Woods, Buffalo, N. Y., dredging operations were carried on at the Horseshoe Reef, at Strawberry Island, and at Tonawanda Harbor, as follows:

Horseshoe Reef.—Dredging began on April 30, 1894. On July 24 a second dredge was placed on the work, and both dredges worked until the close of the season, October 27. A drill boat was employed from May 12 to July 31. All needed blasting was completed at the close of the season of 1894, and there remained of the dredging the removal of a triangular area of about 70 feet in width at the upper end, on the west side of the channel and a ridge at the lower end, near mid-channel, of loose rock, clay, and gravel. A dredge began operations on May 13, 1895, for the season of 1895, and at the close of the fiscal year had nearly completed the channel, and the project, at this point. The width of the completed channel will be fully 400 feet; depth, 18 feet at mean lake level. This will afford an ample channel 18 feet deep down to Strawberry Island, except that opposite the waterworks pier the channel will not have a full width of 400 feet. In his revised estimate, page 2890, Report of Chief of Engineers, 1891, Maj. Amos Stickney estimates the work required at this point as follows: "At waterworks pier (west channel), 15,555 cubic yards rock excavation, at $10, $155,550." It is a question if excavation could be done (should it become necessary) at any reasonable cost at this point owing to the rapid current.

SUMMARY.

	Season of 1894.	Season of 1895 to July 1.
Work of dredges.....hours..	1,986	402.5
Work of tugs.....do....	2,827	402.5
Work of drill boat.....do....	990.5	None.
Holes drilled and blasted.....number..	1,316	None.
Cubic yards dredged and dumped, scow measure.....do....	12,750	2,880
Total earnings of contractors.....	$31,842.99	$3,542.00

It is of special interest to note that, during the past four seasons, there have been removed from this reef 29,773 cubic yards of rock at an expense of $76,480 paid the contractors, an average of $2.57 per cubic yard. This is exclusive of office and inspection expenses. The original depth ranged from 12 to 18 feet.

An obstacle with only 12 feet of water over it, that had been struck by the *Newaygo*, had been located in the main channel about 1,000 feet above the waterworks pier. The obstruction was in very swift water, involving great difficulty in removal, but after considerable delay was removed by the dredging contractors betweeen July 23 and August 17. It proved to be a boiler of the tug *Danforth*, which was capsized in the river several years ago. The total cost of removal was $1,231, an expensive and ugly job.

Strawberry Island.—The channel at Strawberry Island, previously dredged 400 feet wide and 16 feet deep, is to be deepened to 18 feet. Dredging operations to secure this improvement were begun, under contract with Hingston & Woods, Buffalo, N. Y., with one dredge, on May 23, 1895, and carried on continuously to the end of the fiscal year. A second dredge began work on June 11, 1895.

At the close of the year two cuts to the full required depth of 18 feet, along the east side of the channel for a width of 40 feet and length of 1,400 feet, had been nearly completed. The dredging is in broken rock and clay and bowlders, in places very hard, but all of it can likely be removed without drilling.

Summary of work during fiscal year 1895.

Days work of dredge	63.04
Days work of tug	62.48
Cubic yards dredged	4,295
Total amount paid contractors	$4,427.71

Tonawanda Harbor.—With low water prevailing in the lake and river after the opening of navigation, vessels met with considerable difficulty in Tonawanda Harbor. A dredge was sent there and on May 8 began the removal of a bar off the mouth of the creek where the water had shoaled 2 feet. This bar was removed to a depth of 16 feet at mean water level by May 23. Owing to the fact that a water pipe of the village water system lies across the harbor at a depth of not more than 16 feet, materially interfering with the proposed deepening of the harbor to 18 feet, dredging operations were suspended until this pipe should be removed by the proper authorities, and the dredge was transferred to Strawberry Island.

Summary of work during the fiscal year 1895.

Days work of dredge	15.7715
Days work of tug	17.8325
Cubic yards dredged	2,246
Total paid contractors	$1,148.25

Statement of appropriations made for improving Tonawanda Harbor and Niagara River, from August 11, 1888, to the present time.

August 11, 1888	$100,000
September 19, 1890	75,000
July 13, 1892	75,000
August 17, 1894	50,000
Total	300,000

Abstract of proposals for hire of dredging plant on improvement of Tonawanda Harbor and Niagara River, New York, opened by Maj. E. H. Ruffner, Corps of Engineers, at 2 p. m., December 31, 1894, in response to advertisement dated November 30, 1894.

No.	Name and residence of bidder.	For dredge, per day of 8 hours.	For drill boat, per day of 8 hours.	For tug, per day of 8 hours.	For operating U. S. sounding scow, per day of 8 hours.
1	Hingston & Woods, Buffalo, N. Y	$52.00	$52.00	$18.40	$14.60
2	Carkin, Stickney & Cram, Saginaw, East Side, Mich	100.00	5.00	20.00	5.00

Amount available, $49,000. Bid No. 1 recommended for acceptance.

Money statement.

July 1, 1894, balance unexpended		$27,410.17
Amount appropriated by act of August 17, 1894		50,000.00
		77,410.17
June 30, 1895, amount expended during fiscal year		31,443.91
July 1, 1895, balance unexpended		45,966.26
July 1, 1895, outstanding liabilities	$6,500.00	
July 1, 1895, amount covered by uncompleted contracts	39,466.26	
		45,966.26
Amount (estimated) required for completion of existing project		958,090.16
Amount that can be profitably expended in fiscal year ending June 30, 1897		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

COMMERCIAL STATISTICS OF NIAGARA RIVER AND TONAWANDA HARBOR, NEW YORK.

[Compiled from the report of the Buffalo Merchants' Exchange for the year 1894.]

Arrivals and departures of vessels for the year ending December 31, 1894.

District.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Buffalo district	226	103, 811	14	4, 668	229	99, 007	16	4, 232
Niagara district*	351	252, 406	41	14, 974	340	246, 586	28	10, 946
Total	577	356, 217	55	19, 642	569	345, 593	44	15, 178

* Port Day tonnage deducted.

Total arrivals and departures.

District.	Arrivals.		Departures.	
	No.	Tons.	No.	Tons.
Buffalo district	240	108, 479	245	103, 239
Niagara district*	392	267, 380	368	257, 532
Total	632	375, 859	613	360, 771

* Port Day tonnage deducted.

Entered and cleared in 1894, of vessels	1, 245
Decrease in 1894, of vessels	88
Entered and cleared in 1894, of tonnage	736, 630
Increase in 1894, of tonnage	41, 076
Revenue collected on foreign lumber in 1891	$8, 161. 06

Number of vessels and rafts passing the International Bridge in the years 1890, 1891, 1892, 1893, and 1894.

Vessels.	1890.	1891.	1892.	1893.	1894.
Steamers	8, 401	9, 597	10, 132	8, 796	10, 408
Other vessels	3, 896	3, 544	3, 872	2, 820	3, 075
Rafts	54	61	40	25	13
Total	12, 351	13, 202	14, 044	11, 671	13, 496

The decrease in 1893 is attributed to the labor troubles at Tonawanda and the diversion of pleasure traffic from Grand Island to Lake Erie resorts.

Principal receipts for the years 1890, 1891, 1892, 1893, and 1894.

Articles.	1890.	1891.	1892.	1893.	1894.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Lumber	1, 255, 889	884, 646	871, 508	752, 936	712, 087
Shingles	6, 268	6, 307	5, 137	3, 031	3, 776
Laths	3, 260	2, 052	1, 561	3, 308	2, 124
Pickets	.....	.....	991	.....	.....
Posts	792	.....	.....	.....	1, 200
Railroad ties	.....	8, 092	21, 333	5, 152	2, 514
Iron ore	.....	.....	85, 772	66, 617	93, 684
Limestone	.....	.....	7, 728	11, 868	.....
Pig iron	.....	.....	1, 440	1, 460	4, 370
Copper	.....	.....	.....	.....	700
Pulp wood	.....	.....	900	15, 770	17, 812
Timber	735, 000	.....	.....	.....	.....
Tota .. .	2, 001, 209	901, 097	996, 370	860, 142	838, 267

Receipts, in tons and percentages, for the year ending December 31, 1894.

Articles.	Tons.	Percentage.
Lumber in all shapes	739,513	88.22
Iron, copper, etc	98,754	11.78
Total	838,267	100.00

N N 6.

IMPROVEMENT OF NIAGARA RIVER FROM TONAWANDA TO PORT DAY, NEW YORK.

Under provisions of act of September 19, 1890, a survey of this locality was made by Maj. Amos Stickney, Corps of Engineers, and his report thereon of December 31, 1891, with project for improvement, was submitted to Congress and printed as House Ex. Doc. No. 67, Fifty-second Congress, first session (reprinted as Appendix N N 9, Annual Report Chief of Engineers, 1892). This project contemplated the formation of a channel 300 feet wide from Tonawanda down to Conners Island, 200 feet wide from Conners Island to Grass Island, and increasing from 200 to 400 feet wide from Grass Island to Port Day, and construction of embankment, from rock excavated from the channel, extending from Conners Island to Port Day, so as to inclose the lower end of the channel. A channel of 12 feet depth was proposed, although it was incidentally estimated that a channel of 8 feet depth should be first provided, which could be enlarged as an increase of commerce might demand. The cost of the proposed channel, 8 feet deep at mean lake level (6 feet at low water), was estimated at $257,829.

The river and harbor act approved July 13, 1892, appropriated $20,000 for the commencement of work upon the 8-foot channel.

During the season of 1892 the practicability of constant navigation of Niagara River by vessels of upward of 6 feet draft to the harbor back of Conners Island, which is within easy land communication with Port Day, was demonstrated. These commercial developments showed that adherence to the project approved by Congress would be inexpedient and would accomplish no results useful to navigation, and that a modification of the project would be desirable, looking to the excavation of a channel 12 feet deep down to Conners Island and omitting the work proposed below that point to Port Day. For these reasons expenditure of the appropriation of July 13, 1892, was, under the authority of the Secretary of War, suspended until further action in the matter had been taken by Congress.

By act of Congress of August 17, 1894, provision was made for "improving Niagara River from Tonawanda to Port Day, with a view of obtaining a channel of 12 feet depth to Schlosser's Dock, by cutting through the shoal at the head of Conners Island, as indicated in the Report of the Chief of Engineers for 1893, page 3113, $10,000; and the unexpended balance of the appropriation heretofore made in the river and harbor act of July 13, 1892, for the improvement of the Niagara River from Tonawanda to Port Day is hereby reappropriated for this purpose." The amount available under this act was $30,000. Under contract of October 20, 1894, with Hingston & Woods, Buffalo, N. Y., dredging through the shoal at the head of Conners Island was begun on October 22, and closed, for the season of 1894, on December 27, 1894.

Dredging was resumed on May 1, 1895, and was progressing well at the close of the fiscal year. The proposed channel across the bar is to be 200 feet wide and 14 feet deep at mean water level.

The material is hard, indurated clay, with bowlders, overlaid with lighter material, varying in thickness. All can be removed by dredging alone.

On May 31, 1895, three cuts, affording a channel fully 50 feet wide and 14 feet deep at mean water level, were completed, and the announcement could be made that Niagara Falls had entered the list of lake ports. At the close of the fiscal year the channel had been increased in width to 70 feet, at full depth, throughout the entire length of the shoal, viz, 1,700 feet.

Summary for the fiscal year

Hours' work of dredges	1,420.086
Hours' work of tugs	1,393.44
Cubic yards dredged and dumped, scow measure	32,044
Total cost of dredging	$11,090.78
Cost per cubic yard	$0.346

The dredging will be pushed with two dredges, and it is expected that the channel through the shoal will be fully completed before the close of the present contract, December 1, 1895, and a small balance remain for dredging on shoal spots below Tonawanda.

Abstract of proposals for the hire of dredges, drill boat, and tugs for use on the Niagara River, between Tonawanda and Port Day, opened by Maj. E. H. Ruffner, Corps of Engineers, October 15, 1894, at Buffalo, N. Y., in response to advertisement dated September 14, 1894.

No.	Name and residence of bidder	For dredge, per day of 8 hours.	For drill boat, per day of 8 hours.	For tugs, per day of 8 hours.
1	Hingston & Woods, Buffalo, N. Y	$49.92	$49.92	$12.80
2	Carkin, Stickney & Cram, Saginaw, East Side, Mich	79.20	38.00	24.00

Bid No. 1 recommended accepted. Amount available, $30,000.

Statement of appropriations for improving Niagara River from Tonawanda to Port Day, N. Y.

July 13, 1892	*$20,000
August 17, 1894	10,000
Total	30,000

Money statement.

July 1, 1894, balance unexpended		*$20,000.00
Amount appropriated by act of August 17, 1894		10,000.00
		30,000.00
June 30, 1895, amount expended during fiscal year		8,315.77
July 1, 1895, balance unexpended		21,684.23
July 1, 1895, outstanding liabilities	$3,577.50	
July 1, 1895, amount covered by uncompleted contracts	18,106.73	
		21,684.23
Amount (estimated) required for completion of existing project		200,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		20,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

*Reappropriated August 17, 1894.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels at Port Day, N. Y., for the year ending December 31, 1894.

Vessels.	Arrivals from home ports.		Departures to home ports.	
	No.	Tons.	No.	Tons.
Steamers	217	42,579	217	42,579

Total arrivals and departures of vessels	434
Decrease in 1894 of vessels	36
Total arrivals and departures of tonnage	85,158
Decrease in 1894 of tonnage	10,942

Principal receipts, pulp wood.

Fourteen thousand cords of pulp wood, valued at $63,000, included in Tonawanda receipts, were transferred by river to Port Day.

N N 7.

IMPROVEMENT OF WILSON HARBOR, NEW YORK.

Object.—To obtain a 12-foot channel from Twelve Mile Creek to Lake Ontario.

Project.—The present project was submitted in 1873, and proposed to extend piers to the 12-foot curve in Lake Ontario, and to dredge a channel 12 feet deep between the piers and for a width of 100 feet, from the shore end of the piers to the deep water in the creek.

Present works.—The piers are prolongations of piers built by private parties in 1846. At present the west pier is 832 feet long and the east pier 850 feet long. There is also a shore protection for the east pier. This is 360 feet long. The channel has an available depth of 9.5 feet for a width of 100 feet from the west pier.

CONDITION OF THE WORKS.

For several years a detailed estimate has been submitted of the repairs needed to put the piers in good condition. This estimate aggregated $13,364.20. Should an appropriation be made for this harbor it would not be wise to expend it in continuation of the original project before making these repairs. Probably the estimate made in 1890 would not cover the needed repairs to-day, and not less than $15,000 would be needed for this purpose.

The channel.—This remains in fairly good condition for the craft which can pass it, but as this is only 8.5 feet no mercantile vessel can use the harbor. The dredging operations developed a quantity of rock greater than was looked for when the project was made, and an estimate of 4,200 cubic yards of rock, in place, was made of the amount to be removed before the 12 feet desired could be secured. In addition to this an increasing amount of sand is accumulating constantly in the channel. No dredging has been done since 1889, when nearly 25,000 yards was removed.

Estimated cost of work.—In order to complete the present project there remain—

4,200 cubic yards rock excavation, at $3 per cubic yard	$12,600
700 cubic yards dredging, at 30 cents per cubic yard	210
	12,810
Contingencies, 10 per cent	1,281
Total	14,091

But as the needed repairs to the piers exceed this amount an appropriation intended to complete the project and repairs to piers should include the $15,000 additional required for the second or main item. The whole work could be done in one season, and the amount necessary to put the port in the condition intended when its improvement began is $29,091.

There being no funds on hand nothing is intended at present.

Statement of appropriations.

March 3, 1875	$10,000
August 14, 1876	10,000
June 14, 1880	10,000
March 3, 1881	10,000
August 2, 1882	10,000
August 5, 1886	10,000
August 11, 1888	5,000
Total	65,000

Money statement.

July 1, 1894, balance unexpended	$21.49
July 1, 1895, balance unexpended	21.49
Amount (estimated) required for completion of existing project	14,069.51
Amount that can be profitably expended in fiscal year ending June 30, 1897	29,091.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. J. C. QUINTUS, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., July 15, 1895.

MAJOR: I would respectfully submit the following report on inspection of Wilson Harbor, New York, made by me July 12, 1895:

The piers are in the same condition as noted in the annual report for 1889 and the same repairs are needed.

The west pier is of course the more exposed and requires the greater amount of work done on it. There is needed a new superstructure over the outer 500 feet of the pier. With stone filling on hand, and, basing estimate on cost of work done in 1889, the cost of this new superstructure would be:

500 linear feet, at $15 per linear foot $7,500

The inner 200 feet of the west pier, being inside of the beach line, will stand, no doubt, with minor repairing, for some years.

With only a small amount of money available, work on the west pier could be confined to repairing the extreme outer end of the pier and patching the deck where needed at a cost of about $700.

The east pier is intact and should last for some years with minor repairs to deck and refilling with stone the outer end, now empty. At the time of inspection there were 200 planks partly decayed along the structure. Many of the worst places have been patched by the Lake Island Park Company to prevent accidents to excursionists visiting the park. The stone filling in this pier is from 1 to 2 feet deep below deck; not sufficient to hold it. The repairs to deck and outer end could likely be made for $300.

The pile protection at inner end of west pier is in good condition, but no longer needed.

The east breakwater is as good as new.

The channel.—The channel was dredged in 1889, and according to map, office file 41-3, after dredging, was 9 to 10 feet deep through outer half of channel between piers and 12 to 12⅓ feet through inner half and to the Tuscarora Island Channel.

From the soundings taken, and inspection, and information obtained from residents, it is evident that the channel has now returned nearly to its condition before dredging, and is substantially as shown on map of 1887, 39-3. This would indicate a filling in of from 2 to 5 feet, through the inner half of channel.

In July, 1895, with water in the lake 2 feet low, the *Garden City*, draft 6 feet, can only navigate the outer half of the channel. In a sea this vessel also strikes bottom at entrance between piers. The exact condition of the channel and existence or nonexistence of rock can only be determined by survey. If no rock should be met with, a channel of 12 feet depth, 150 feet width, could be made at a cost of $5,000.

The estimate made in 1889, to complete the channel and all work in rock, was $12,810. This estimate would no doubt secure the required channel to the entrance of Tuscarora Island Channel.

The project calls for a channel "to deep water in the creek." This "deep water," 10 to 12 feet, exists for a distance of a mile or more, and begins opposite the pavilion in the park. It is separated from the deep water at the entrance of Tuscarora Island Channel by a bar 1,000 feet long, on which there is a depth, at mean level, of 5 to 6 feet. The material appears to be soft. A channel across the bar and 150 feet wide would cost $10,000.

The work at Wilson Harbor may be classed as follows:

Urgent work.

Repairing piers	$1,000
Dredging channel, 150 feet wide and 10 feet deep, 1,400 feet long	3,500
Total	4,500

Necessary work.

Repairing piers	$500
Rebuilding 500 linear feet west pier	7,500
Dredging 10-foot channel	3,500
Total	11,500

To complete project.

Dredging channel to Tuscarora Island Channel, 1,400 feet long, 150 feet wide, to depth of 12 feet (estimated, 1889)	$14,000
To deep water in creek above bar, channel 150 feet wide to 12 feet depth would cost	10,000

The dredging under "urgent" and "necessary" work is estimated as soft digging at 25 cents per cubic yard, scow measure. As the location and amount of rock in the outer end of channel is unknown, it would no doubt be advisable to do further dredging by hired plant and redredge the inner half of the channel first.

Respectfully submitted.

J. C. QUINTUS, *Assistant Engineer.*

Maj. E. H. RUFFNER,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS OF WILSON HARBOR, NEW YORK.

Arrivals and departures of vessels for the year ending December 31, 1894.

Vessels.	Arrivals from—				Departures to—			
	Home ports.		Foreign ports.		Home ports.		Foreign ports.	
	No.	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*	*No.*	*Tons.*
Steamers	.....	.....	36	13,035	.....	.....	36	13,035
Sailing vessels	2	503	1	56	2	503	1	56
Total	2	503	37	13,091	2	503	37	13,091

Total arrivals and departures of vessels in 1894	78
Decrease of vessels in 1894	21
Total arrivals and departures of tonnage in 1894	27,188
Decrease of tonnage in 1894	8,672
Amount of revenue collected in 1894	$41.25
Value of exports in 1894	$160
Value of imports in 1894	$483

Principal exports, fruit; principal imports, shingles.

N N 8.

IMPROVEMENT OF OLCOTT HARBOR, NEW YORK.

Object.—To obtain a protected channel 13.5 feet deep at mean lake level from Lake Ontario to the bridge crossing Eighteen Mile Creek at Main street.

Project.—The first project for this work was submitted in 1846, but it was not executed. The present project was adopted in June, 1891, and is substantially the project of 1866 with some enlargements. It provides for two piers extending into the lake, with a channel between them. The piers are nearly parallel to each other, about 200 feet apart. The east pier is 850 feet long and the west pier 873 feet. Between the piers the channel is about 180 feet wide, the limiting lines being 10 feet from the piers, and from the shore end of the piers it decreases to 98 feet in width at the Main Street Bridge. The channel depth is 13.5 feet, measured from mean lake level.

Present work.—East and west piers and the channel between them.

Condition of works.—Both piers are in good condition, and the channel has the full depth between the limits as given.

Proposed operations.—The project for this harbor is completed, and the remaining funds will be used for maintenance.

Statement of appropriations made for improving harbor at Olcott, N. Y., from March 2, 1867, to the present time.

March 2, 1867	$60,000	March 3, 1881	$3,000
July 11, 1870	10,000	August 5, 1886	10,000
March 3, 1871	5,000	August 11, 1888	5,000
June 10, 1872	10,000	September 19, 1890	30,000
March 3, 1873	10,000		
June 23, 1874	10,000	Total	163,000
March 3, 1875	10,000		

Money statement.

July 1, 1894, balance unexpended	$5,376.23
June 30, 1895, amount expended during fiscal year	67.59
July 1, 1895, balance unexpended	5,308.64
July 1, 1895, outstanding liabilities	15.00
July 1, 1895, balance available	5,293.64

COMMERCIAL STATISTICS OF OLCOTT HARBOR, NEW YORK.

Arrivals and departures of vessels for the year ending December 31, 1894.

Vessels.	Arrivals from foreign ports.		Departures to foreign ports.	
	No.	Tons.	No.	Tons.
Steamers	1	219	1	219
Sailing vessels	1	12	1	12
Total	2	231	2	231

Total arrivals and departures of vessels during 1894	4
Decrease of vessels in 1894	8
Total arrivals and departures of tonnage in 1894	462
Decrease of tonnage in 1894	1,232
Revenue collected in 1894	$2
Value of exports in 1894	$450

Principal exports, fruit.

N N 9.

IMPROVEMENT OF OAK ORCHARD HARBOR, NEW YORK.

Object.—To furnish a protected channel 200 feet wide and 12 feet deep from deep water in Lake Ontario to deep water in Oak Orchard Creek.

Project.—The original plan for this improvement, adopted in 1836, consisted in contracting the mouth of the creek to 200 feet by two breakwaters running from the shore, one on each side, and a channel between two parallel piers from the 12-foot curve in the creek to the same curve in the lake. This project, except as to the breakwaters, is still in force.

Present works.—The present works are the east and west piers and a shore protection. The piers extend to the 12-foot curve in the lake. The shore protection, beginning at the shore end of the east pier, was built in 1889 and is 91 feet long. The channel has a depth of 13.5 feet at mean lake level for the whole width between the piers, excepting 10 feet along each pier.

Condition of the works.—The east pier and the shore protection are in good condition and need but slight repairs. The west pier has settled, for a length of 130 feet, about 2½ feet on the harbor side, where the pier intersects the shore line; also on the outer end toward the lake. Both settlements were caused by very rough weather, in the fall of 1891, during the low stage of water, 2.2 feet below mean lake level, undermining those places. The channel is in good condition.

Proposed operations.—The project of this harbor has been completed, but a certain amount of money should be appropriated to keep it in repair.

Statement of appropriations made for improving harbor at Oak Orchard, N. Y., from July 4, 1836, to the present time.

July 4, 1836	$5,000	August 14, 1876	$2,000
March 3, 1837	5,000	June 18, 1878	2,000
July 7, 1838	5,000	March 3, 1879	1,000
June 11, 1844	5,000	June 14, 1880	500
August 30, 1852	10,500	August 2, 1882	3,000
March 2, 1867	87,000	July 5, 1884	5,000
July 11, 1870	8,000	August 5, 1886	12,500
March 3, 1871	10,000	August 11, 1888	6,000
June 19, 1872	2,500	September 19, 1890	5,000
March 3, 1873	10,000		
June 23, 1874	10,000	Total	205,000
March 3, 1875	10,000		

Money statement.

July 1, 1894, balance unexpended	$462.34
June 30, 1895, amount expended during fiscal year	30.00
July 1, 1895, balance unexpended	432.34
July 1, 1895, outstanding liabilities	7.50
July 1, 1895, balance available	424.84

COMMERCIAL STATISTICS OF OAK ORCHARD HARBOR, NEW YORK.

Arrivals and departures of vessels for the year ending December 31, 1894.

Vessels.	Arrivals from foreign ports.		Departures to foreign ports.	
	No.	Tons.	No.	Tons.
Steamers	1	31	1	31
Sailing vessels	3	146	3	146
Total	4	177	4	177

Total arrivals and departures of vessels in 1894	8
Total arrivals and departures of tonnage in 1894	354
Decrease of tonnage in 1894	124
Amount of revenue collected in 1894	$109.58
Value of imports in 1894	$1,038

Principal imports, shingles, laths, and posts.

N N 10.

PRELIMINARY EXAMINATION OF DUNKIRK HARBOR, NEW YORK.

[Printed in House Ex. Doc. No. 77, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 11, 1894, from Maj. E. H. Ruffner, Corps of Engineers, of the results of a preliminary examination of Dunkirk Harbor, New York, made to comply with the provisions of the river and harbor act of August 17, 1894.

Major Ruffner is of opinion that Dunkirk Harbor is worthy of improvement with a view of securing a depth of 16 feet, and estimates that the survey necessary to the preparation of plan and estimate for improvement will cost $800; but Col. H. L. Abbot, Corps of Engineers, the division engineer, dissents from the views of Major Ruffner, and in his opinion the harbor is not worthy of improvement by the General Government to the extent of obtaining a navigable depth of 16 feet.

In my opinion Dunkirk Harbor is worthy of improvement, and it is recommended that the survey proposed by Major Ruffner at a cost of $800 be made.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., September 11, 1894.

GENERAL: In accordance with the provisions of the river and harbor act of 1892 a preliminary examination was made of Dunkirk Harbor, New York, with a view of securing 16 feet of water. That report was

published as House Ex. Doc. No. 119, Fifty-second Congress, second session, and appears in pages 3119–3130 of the Report of the Chief of Engineers, United States Army, for 1893. Since the date of that report the breakwater has been lengthened 250 feet, bringing the total length to 1,591 feet, and the breakwater and pier have been put in good condition by extensive repairs. The channel leading into the harbor and the basin near the piers has been thoroughly dredged to a depth of 13 feet.

During 1892, 60 vessels arrived and 60 departed, and in 1893, 54 vessels arrived and 53 departed.

No change has occurred in the situation other than the above. From that report I may extract the following, with some changes and some additions:

The history of Dunkirk Harbor shows that the attempt to form a protected harbor, with a 13-foot channel to it, has only partially succeeded. Only four sevenths of the outlying breakwaters were ever constructed and maintained. As a consequence, piers could not safely be built within the harbor, nor could vessels lie there in all storms. For this reason, and because commerce has outgrown a 13-foot depth of channel, Dunkirk never recovered from the depression in navigation interests, which was at its lowest on the lakes in 1876–77, and did not participate in the revival which followed, and which so prospered Buffalo and Tonawanda.

If to this history I add that at present the piers and wharves in Dunkirk Harbor are most dilapidated and shorn of business, and that no signs of any repairs to them, and that no signs of improvement of any kind are visible, we shall be safe in concluding that the only alternatives before us are either the harbor should be improved, completed, and deepened, or else the United States should cease all expenditures thereon. It clearly is of no avail to preserve the harbor at an annual expense of from $5,000 to $10,000 for less than 100 vessel entrances and clearances. Such vessels can use the harbor as it is and will be without further expense.

Would the commerce of the port improve if a deep and safe harbor were here, and can such be made without enormous expenditure? An affirmative answer to this question will declare the harbor "worthy of improvement by the General Government."

COMMERCIAL OUTLOOK.

There are five railroads passing through Dunkirk. The Lake Shore and Michigan Southern is the most important, with its large east and west transportation of all kinds of products and material. By this line Buffalo is 40 miles distant from Dunkirk, which is the first important station after leaving Buffalo for Chicago.

The New York, Chicago and St. Louis Railroad is parallel to the Lake Shore from Buffalo to Chicago, and passes through Dunkirk in the southerly portion of the city. The Western New York and Pennsylvania Railroad might, under certain conditions, be the most important railroad, for the interests of Dunkirk, entering that city. This railroad has one line from Buffalo to Dunkirk (there leaving the lake shore) to Oil City, 137 miles. A cross line from Oil City to Olean, 116 miles, or to Bradford, 97 miles, and a second main line from Buffalo to Olean and Emporium, 211 miles, make, with other minor branches, a network which enables the road to do a large coal business. If this road should choose to use Dunkirk as a coal harbor (in case the harbor was improved) it would be able to throw a heavy tonnage there.

The Dunkirk, Allegheny and Pittsburg Railroad (now owned or controlled by those who control the New York Central) extends from Dunkirk to Titusville, 91 miles. By building, or through arrangement with existing lines, this road might also use Dunkirk as a point for shipping coal in the future.

Lastly, the New York, Lake Erie and Western Railroad, which is the only road that has tried in years past to use the port, and which has been forced to abandon its decaying dock and elevator, lately torn down, yet has its lines connecting with pier and water front. This road, by its branch 46 miles long to Salamanca, is in connection with its main east and west line, which is joined at Hornellsville by the line from Buffalo.

From Dunkirk to Jersey City by this route is 459 miles. From Buffalo via Hornellsville to Jersey City it is 423 miles. Vessels coming down the lakes have 30 miles farther to go to reach Buffalo than to reach Dunkirk, so that the total to New York via either way is practically the same. The whole matter rests very largely with the railroads. If in the future they should become crowded in dock room, or find it more convenient to throw a part of their bulky business via Dunkirk instead of via Buffalo they would do so. It is quite certain, however, that the harbor must be improved before the railroads would entertain any ideas about using it. The proximity to Buffalo on one side and Erie on the other must be overcome by offering equal inducements at Dunkirk.

Should a coal railroad see fit to use the harbor it would be in rivalry or in relief to Buffalo, and only those in control of such roads could decide this matter. At present they would not in all probability entertain the idea of using the harbor. But the harbor is there, and half finished, and a reasonable expenditure on it might secure a large business. Should it seem advisable to the various coal railroads, or any one or two of them, to develop shipping facilities at Dunkirk, as has recently been done at Ashtabula and at Conneaut, it would be but a short time before the importance of Dunkirk as a port would vastly increase. Inasmuch as coal, grain, lumber, and iron ore form more than nine-tenths of lake shipments, and areas for handling these products in Buffalo and vicinity are limited at present, it is not unreasonable to imagine a time in the not far distant future when it might be profitable to divert a portion of this freight to Dunkirk, since it is practically as near New York as Buffalo is, and use might be made of a harbor there. Most certainly the change will not be made until the harbor is made.

ENGINEERING STANDPOINT.

The fact that the United States has expended a large sum of money upon this harbor is a good reason why the harbor should not be abandoned, providing that the improvements projected can be done at a reasonable cost. If, after the expenditure of $500,000 in sixty-five years, an additional sum of $500,000 would render the harbor available for all but the largest craft, would not such an investment be such as a business community should adopt?

The simplest way to secure a safe harbor at Dunkirk with 16 feet of water would be to close the present channel entirely by running a crib breakwater from the beacon crib to the west end of the breakwater, about 725 feet; extend the breakwater the 1,100 feet that it lacks, thus protecting the harbor from all dangerous storms and entirely excluding all sand from the harbor for an indefinite term of years, and then dredge a channel from deep water in the lake to the docks, 2,825 feet, and a

basin at the docks 750 feet square. To secure 16 feet for craft, dredging should be carried to 17 feet depth.

For the reasons thus given I deem Dunkirk Harbor, with a view to securing 16 feet of water, as "worthy of improvement." A survey should be careful, and the soundings over all areas proposed to be dredged should be numerous and exact; hence such a survey would probably cost not less than $500, besides the subsequent reduction and mapping, $300 more.

Respectfully submitted.

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Henry L. Abbot, Corps of Engineers, Division Engineer, Northeast Division.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, September 20, 1894.

Respectfully forwarded to the Chief of Engineers, United States Army.

While not prepared to recommend the total abandonment of this harbor, which now has a depth of 13 feet, I am of opinion, for the reasons stated in my indorsement upon the preliminary examination, report of Major Ruffner, dated August 5, 1892 (pp. 3119, 3120, Report of the Chief of Engineers for 1893), that no greater depth than 13 feet should be attempted until there is clearly a commercial demand for a deep-water harbor between Buffalo and Erie.

To provide such a harbor at this locality will, in my judgment, call for "enormous expenditure," for a basin much larger than that proposed, 750 feet square, will, I think, be needed to accommodate a lake traffic commensurate with the necessary outlay. Expensive rock excavation must enter into the estimates, and at best the approach in storms will be difficult and dangerous if, as suggested, the present channel be sacrificed to obtain a safe harbor.

For these reasons I am of opinion that Dunkirk Harbor is not worthy of improvement by the General Government to the extent of obtaining a navigable depth of 16 feet.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

N N 11.

ESTABLISHMENT OF HARBOR LINES IN THE OUTER HARBOR OF BUFFALO, NEW YORK.

WESTERN NEW YORK AND PENNSYLVANIA R. R. CO.,
PRESIDENT'S OFFICE,
Buffalo, N. Y., September 19, 1894.

DEAR SIR: The undersigned is president and receiver of the Western New York and Pennsylvania Railroad Company, a corporation duly organized under the laws of Pennsylvania and New York.

The said corporation is the owner of about 1,500 linear feet frontage on the shore of the outer harbor of Buffalo, N. Y., and desires to avail itself of the advantage of its position on the said harbor by the con-

struction of docks and piers along its frontage thereon, and with this end in view respectfully asks that the harbor lines in said harbor be speedily established, in order that the proposed docks and piers may conform thereto.

Very respectfully,

SAML. G. DE COURSEY,
President and Receiver.

Hon. DANIEL S. LAMONT,
Secretary of War.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 24, 1894.

Respectfully referred to Maj. E. H. Ruffner, Corps of Engineers, for report.

If, in the opinion of Major Ruffner, harbor lines should be established at this locality, under the provisions of section 12 of the river and harbor act of August 11, 1888, as amended and reenacted by section 12 of the river and harbor act approved September 19, 1890, he will please submit to this office a map showing the harbor lines which, in his judgment, should be established by the Secretary of War.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Third indorsement.]

BUFFALO, N. Y., *September 26, 1894.*

Respectfully returned to the Chief of Engineers, U. S. A.

Harbor lines should be established in the outer harbor of Buffalo before any construction of docks be begun. The outer, or pierhead, line naturally runs parallel to the breakwater, and starts from the outer end of the south pier. This would give a width of about 1,800 feet to the outer harbor. This is more than vessels can now use for anchorage over the northern half since the 12-foot contour is nearly that of the suggested line. Hence, no contraction could result from taking this as a permanent line.

No filling should be allowed in the outer harbor beyond the present water lines, except it be placed within permanent bulkheads (cribs or sheet piling) to retain it in place. This provision should be distinctly stated. Subject to this provision, bulkhead lines could correspond with the pierhead line. A tracing* is inclosed with the lines and contours marked.

E. H. RUFFNER,
Major of Engineers.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 27, 1894.

Respectfully referred to Col. H. L. Abbot, Corps of Engineers, Division Engineer, Northeast Division, for his views and recommendations.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

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* Not printed.

[Fifth indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, October 1, 1894.

Respectfully returned to the Chief of Engineers, U. S. A. I concur with the views of Major Ruffner, and recommend that the harbor lines as indicated by him, subject to the conditions as to filling contained in his indorsement of September 26, 1894, be approved as a coincident bulkhead and pierhead line for the portion of the harbor lying between the United States South Pier and the Sand Catch Pier.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

[Sixth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 3, 1894.

Respectfully returned to the Secretary of War.

This is a request for the establishment of harbor lines for the outer harbor of Buffalo, N. Y.

The subject has been under consideration by Maj. E. H. Ruffner, Corps of Engineers, to whose report, in third indorsement hereon, attention is respectfully invited.

Major Ruffner submits a drawing on which is delineated a black line marked "Proposed harbor line," and he recommends the establishment of this line as a coincident bulkhead and pierhead line for that portion of the harbor between the United States south pier and the sand-catch pier, subject to the provision that no filling shall be allowed in the outer harbor beyond the present water line except it be confined within permanent bulkheads.

The views of Major Ruffner meet the approval of the division engineer, and are concurred in by this office. It is recommended that the line selected be approved and that the Secretary place his approval on the accompanying drawing.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Seventh indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 11, 1894.

Respectfully returned to Major Ruffner.

The Secretary of War, before acting upon these papers, would like to have you consult the riparian owners affected by the proposed line and obtain their views as to its establishment.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Eighth indorsement.]

BUFFALO, N. Y., *December 14, 1894.*

Respectfully returned to the Chief of Engineers with report of progress inclosed, asking for further instructions. Tracing retained and blue print sent.

E. H. RUFFNER,
Major of Engineers.

[Ninth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 20, 1894.

Respectfully returned to the Secretary of War.

Attention is invited to Major Ruffner's letter of December 14, 1894, herewith, reporting his action respecting views of the riparian owners affected by the proposed harbor lines, and he now submits the accompanying tracing* showing harbor lines recommended for approval.

His views are concurred in, and it is recommended that the proposed harbor lines, as shown on the accompanying tracing, be approved, subject to the provision that no filling shall be allowed in the outer harbor beyond the present water line except such filling be confined within permanent bulkheads.

It is recommended that the Secretary place his approval upon the tracing* inclosed.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

NOTE.—The lines described in the above report and shown on the map accompanying were approved by the Secretary of War under date of December 21, 1894, the approval being indicated on the map.*

REPORT OF MAJ. E. H. RUFFNER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., December 14, 1894.

SIR: In carrying out your instructions relative to proposed harbor lines in the outer harbor of Buffalo, as conveyed in your indorsement of October 11, I have had some delay in securing the views of the riparian owners affected by the proposed line, and am only now enabled to make some definite report.

It seems that all owners are interested in securing as much room as possible in filling out land for dock purposes. They are more concerned with this than with reaching deep water by short piers, and economy of pier construction and of dredging. As the line is first drawn it is to be noted that owners at the north end of the harbor have more space between the proposed harbor lines than those at the south end, because the City Ship Canal is the limiting line on the east. As a consequence those owners at the north end of the harbor accepted the suggested line, and those at the south end, notably the New York, Lake Erie and Western Railroad and the Buffalo Creek Railroad, both owning large frontages, asked that the line be shifted outward so as to give more for filling purposes. After personal and written exchange of views I have proposed and they have accepted the following change:

Let the first line stay unchanged for 5,500 feet, this giving about 1,440 feet of building space between the ship canal and the harbor line. Then swing the remainder of the line and hold it parallel to the west line of the ship canal and 1,440 feet from it. This arrangement puts all riparian owners on the same footing and narrows the harbor space as little as may be.

All owners have agreed, verbally or in writing, to this combination. This statement excepts a few lots whose owners could not be reached, and others who did not accept my invitation to express their views.

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* Not printed.

All of the principal interests have been heard from, and the Western New York and Pennsylvania Railroad have accepted the proposed line in front of their property.

The blue print inclosed shows the idea, and, if acceptable, shall send a new tracing prepared in accordance with what is now suggested.

I think the whole is in accordance with the interests of navigation and of property owners.

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

N N 12.

ESTABLISHMENT OF HARBOR LINES IN NIAGARA RIVER IN THE VICINITY OF FOOT OF FERRY STREET, BUFFALO, NEW YORK.

UNITED STATES ENGINEER OFFICE,
Buffalo, N. Y., January 12, 1895.

SIR: During the past eight months parties holding certain leaseholds from the canal authorities on the canal lands in the vicinity of the foot of Ferry street, Buffalo, to wit, the International Ferry Company, Louis Harbrecht, for himself and for certain named companies, and Jacob F. Schoellkopf, have asked permission to construct docks and piers, or to make certain changes in docks in that vicinity. The last named has now asked that harbor lines be established here so that all parties may know just how far they can go and under what regulations they can build. This request can be granted with advantage to all concerned and to the interests of navigation.

By extending the harbor lines established for Squaw Island in July last from the upper or southern end of the island to a point 50 feet outside of the face of the main sewer opening, some 505 feet south of the foot of Ferry street, and a permanent and well-known mark, a straight line some 3,100 feet long is secured, well adapted to serve as a pierhead line. There is room behind it for docks, etc., and navigation is amply protected. The whole area, save the upper inside narrow strip, is in eddy. All material deposited behind this line, liable to be carried away by the action of the river, should be inclosed in suitably built, permanent bulkheads. A tracing * is inclosed showing all details and the length and bearing of each course. The line at Squaw Island is taken from the recorded description. (See Annual Report, Chief of Engineers, 1894, pp. 2452–2454.)

Very respectfully, your obedient servant,

E. H. RUFFNER,
Major of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. H. L. Abbot, Corps of Engineers, Division Engineer, Northeast Division).

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* Not printed.

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, January 14, 1895.

Respectfully forwarded to the Chief of Engineers, U. S. A., recommending approval.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
January 15, 1895.

Respectfully submitted to the Secretary of War.

Maj. E. H. Ruffner, Corps of Engineers, recommends, for reasons stated, that the pierhead line established by the Secretary of War July 23, 1894, be extended southward some 3,100 feet to a point 50 feet outside of the face of the main sewer opening, some 505 feet south of the foot of Ferry street, Buffalo, N. Y., as shown on the tracing herewith submitted.

It is recommended that the extension of the pierhead line as proposed by Major Ruffner be approved, subject to the condition that all material deposited behind this line, liable to be carried away by the action of the river, shall be inclosed in suitably built permanent bulkheads. It is further recommended that the Secretary place his approval upon the accompanying tracing.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Third indorsement.]

WAR DEPARTMENT,
January 21, 1895.

Approved as recommended by the Chief of Engineers, approval having also been placed upon the inclosed tracing.

By order of the Secretary of War:

JOHN TWEEDALE, *Chief Clerk.*

LETTER OF MR. JACOB F. SCHOELLKOPF.

BUFFALO, N. Y., *January 10, 1895.*

DEAR SIR: As I intend to make some improvements to my property on the Niagara River, foot of Ferry street, such as building docks and piers, and as other parties along this part of the river will shortly make similar improvements, we would like to have the Government establish a harbor line along that part of the river, so we will know just how far we can go out without interfering with navigation.

An early answer will oblige yours, truly,

J. F. SCHOELLKOPF.
Per L. S.

Maj. ERNEST H. RUFFNER, *City.*

APPENDIX O O.

IMPROVEMENT OF HARBORS ON LAKE ONTARIO EAST OF OAK ORCHARD, NEW YORK.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Harbor at Charlotte, N. Y.
2. Pultneyville Harbor, New York.
3. Harbor at Great Sodus Bay, New York.
4. Harbor at Little Sodus Bay, New York.
5. Oswego Harbor, New York.
6. Harbor at Sacketts Harbor, N. Y.

EXAMINATION.

7. Channel connecting Irondequoit Bay with Lake Ontario, New York.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., July 10, 1895.

GENERAL: I have the honor to transmit herewith * * * my annual report for the following works in my charge.

* * * * * * *

I have the honor to be, very respectfully, your obedient servant,

DAN C. KINGMAN,
Captain of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

O O 1.

IMPROVEMENT OF HARBOR AT CHARLOTTE, NEW YORK.

OBJECT.

To secure a navigable channel at the mouth of the Genesee River on Lake Ontario.

Charlotte Harbor is the port of the city of Rochester, which is situated 2 miles above the head of the navigable part of the river forming the harbor.

PROJECT.

1829.—To obtain a channel 480 feet wide and 12 feet deep, formed and protected by parallel piers extending to deep water of the lake, executed in 1834.

1881.—To secure and maintain, by pier extension and dredging, a channel of navigable width and 15 feet depth at extreme low water. No dredging has heretofore been done, the channel having been formed and kept open with 12 feet depth by the current of the Genesee River,

The following appropriations have been made for this work:

May 23, 1828	$300.00	April 10, 1869, allotment	$1,000.00
March 2, 1829	10,000.00	July 11, 1870	12,000.00
March 3, 1829	13,335.00	March 3, 1871	10,000.00
March 2, 1831	16,670.00	March 3, 1875	5,000.00
February 24, 1832	16,000.00	June 18, 1878	1,000.00
March 2, 1833	15,000.00	March 3, 1879	1,000.00
June 28, 1834	20,000.00	June 14, 1880	5,000.00
March 3, 1835	2,390.00	March 3, 1881	2,500.00
July 2, 1836	20,000.00	August 2, 1882	35,000.00
March 3, 1837	10,000.00	July 5, 1884	20,000.00
July 7, 1838	25,000.00	August 5, 1886	26,250.00
June 11, 1844	10,000.00	August 10, 1888	45,000.00
August 20, 1852	20,000.00	September 19, 1890	25,000.00
March 3, 1853	176.10	July 13, 1892	25,000.00
June 28, 1864	25,000.00	August 17, 1894	15,000.00
June 23, 1866	75,607.30		
July 25, 1868, allotment	1,100.00	Total	509,328.40

PRESENT WORKS.

The piers which define and maintain the channel are formed of cribs of timber, 20 feet wide and 30 feet long, sunk end to end in as close contact as practicable by filling with loose stone.

The cribs forming the original work were built of logs hewed flat, and were allowed to settle into the natural sand bottom upon which they were placed, each crib having 2 to 4 oak guide piles driven on each side of it to keep the crib in line while settling into the sand. A continuous timber superstructure was then built upon the cribs for the full width of 20 feet and 3 to 5 feet in height above mean lake level. The whole was then filled with loose stone and decked with 3-inch plank. The cribs, being below water and not subject to decay, were built of hemlock timber, fastened together with tie heads and driftbolts, while the continuous superstructure was built of white-pine timber and plank, similarly fastened. The latter has a life of about 15 years.

(*1*) *West pier.*—This has a total length of 3,622 feet, in addition to a shore return of 137 feet. It is composed of the following parts:

Section A, from the shoulder angle of the return at the shore line of 1829, 554 feet northward toward the lake. It was built in 1829 and last repaired in 1867. Owing to the fact that the shore line has advanced beyond it, further repairs are not considered necessary.

Section B, 564 feet long, built in 1829–1834 and last repaired in 1885 by the Ontario Beach Improvement Company, by whom it is used as a wharf. It is within the present shore line.

Section C, 1,402 feet long, built in 1829–1834 and last repaired in 1887–88.

Section D, 235 feet long, built in 1829–1834, and last repaired in 1891.

Section E, 303 feet long, built in 1883; not since repaired.

Section F, 365 feet long, built in 1893; not since repaired.

(*2*) *East pier.*—This has a total length of 2,896 feet in addition to an abandoned shore connection 402 feet in length, upon which the super-

structure has not been removed since its original construction in 1829–1834 and which is now destroyed to nearly the level of the surrounding bottom, only its guide piles showing above low water. The width was originally 20 feet throughout, the substructure being of separate cribs and the superstructure of continuous timberwork, similar in detail to the west pier. It is composed of the following parts:

Section A, 325 feet long, measured toward the lake, built in 1829–1834; last repaired in 1867. It is well within the shore line, and further repairs by the United States are not considered necessary. The superstructure was renewed in 1894 by the Summerville Beach Improvement Company.

Section B, 100 feet long, built in 1829–1834; last repaired in 1887 by the United States Life-Saving Service, of whose station it forms the water front.

Section C, 225 feet long, built in 1829–1834; last repaired in 1889.

Section D, 797 feet long, built in 1829–1834; last repaired in 1886–87.

Section E, 995½ feet long, built in 1829–1834, and last repaired in 1890.

Section F, 303 feet long, built in 1883, and not since repaired.

Section G, 150½ feet long, built in 1884–85, and not since generally repaired.

CHANNEL.

The original project of 1829 proposed to obtain a channel 480 feet wide and 12 feet deep, protected by parallel jetties, and extending from deep water within the mouth of river to deep water in the lake. It was entirely successful; the channel was formed and maintained with the desired depth by the scouring action of the river alone from the time of building the jetties in 1829.

But in 1881, in compliance with the increasing demands of commerce, it was proposed to secure and maintain, by extending the jetties and dredging, a channel 15 feet deep at extreme low water. No dredging had ever been necessary to maintain the 12-foot depth. In pursuance of this enlarged project some 1,220 feet of jetties have been built, which, however, does not extend them to the required depth in the lake, and a large amount of dredging has been done.

The first dredging was done in 1888, and it was continued as means were provided until the fall of 1892. About 270,000 cubic yards of material, mostly sand, were removed, and a channel, 380 feet wide throughout and not less than 15 feet deep at extreme low water, was formed between the jetties. Fifty years' experience had conclusively shown that the river could not of itself remove this material.

When it was removed by dredging it remained to be seen whether the current would be sufficient to keep it from filling up again. The results of the survey of 1894 seem to answer this question in the negative. The Genesee River had been subject to an unusual flood in the spring. It overflowed its valley, eroded its banks extensively, and even shifted its channel in places. Consequently its water was loaded with silt, a part of which it deposited in the jetty channel, and a very material shoaling resulted.

The fill amounted to more than 4 feet in places, and the channel was seriously impaired. The quantity of material deposited between the jetties was not less than 60,000 cubic yards.

In September, 1894, dredging was resumed with the United States plant, and by the end of the season about 38,000 cubic yards of the deposit had been removed, thus restoring the depth, but not the width of the channel. After the spring freshets of 1895 it was found that this new channel was considerably impaired.

In view of the fact that this is a silt-bearing stream for at least two or three months of the year, and has very little current for the remaining nine or ten months, it would perhaps be too much to expect that a 15-foot channel as wide as 330 feet could be maintained without periodical dredging. The 1881 project is silent upon this point.

The river above the drawbridge, where its condition is remarkably stable, has a width of about 300 feet, a maximum depth of about 27 feet at the present stage of water, and an average depth of something over 17 feet, and an area of cross section of about 5,500 square feet. This shows how large a channel the river can create and maintain for itself. The channel between the jetties had, after dredging, an area of cross section of about 7,500 square feet. Filling in would seem inevitable if the river brings down much silt.

It seems necessary, therefore, to decide now whether, in order to carry out the existing project, resort shall be had to periodical dredging, or to some suitable contraction of the channel between the jetties by the construction of spurs, as was done at the South Pass of the Mississippi River and elsewhere.

OPERATIONS.

The United States dredging plant was docked and repaired, and on the 18th of September was sent to Charlotte, where it arrived the same day.

It was proposed to form a cut 16 feet deep and 150 feet wide, and midway between the jetties. It was estimated that this work would require the removal of about 60,000 cubic yards of river silt, place measurement.

The dredge was employed upon this work until December 20, when the winter weather compelled the suspension of work till spring. The plant was laid up at Charlotte, in the care of a watchman. During the time it was employed the dredge removed 38,000 cubic yards of material.

In the spring the dredge was supplied with a new set of spuds and otherwise put in order, and the work in the channel was resumed on the 18th of April and continued until the end of the fiscal year. During this period 29,650 cubic yards of material was removed, making 67,650 cubic yards in all. This apparently exceeds the estimated amount, which was 60,000 cubic yards, but the discrepancy is mainly due to the difference between measurement in place and measurement in the scow.

There has been expended for dredging during the fiscal year $6,470.94; for care and repair of plant, $1,066.24; for engineering and office expenses, $925.60; for services of watchman on jetties, for reading the gauge, and for the collection of commercial statistics, $600.

REMARKS.

I would recommend that the jetties be extended, according to the project, to the 15-foot contour as rapidly as the means provided will allow, and I would also recommend that the method of maintaining the prescribed depth of 15 feet at low water between them be fully considered and made the subject of a definite project. The choice must be between periodical dredging and channel contraction, for the present width is so great that the river current can not of itself maintain the required depth of 15 feet.

It is proper to invite attention to the fact that the United States has constructed some 7,057 linear feet of jetty work at this place, of which 4,975 is valuable and necessary to the maintenance of the harbor. The rest of it has been absorbed by the advance of the shore line, and further repairs will probably not be required. Five thousand feet of jetty, in round numbers, therefore, must be kept in good order. As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below the general level of the water is not subject to decay, and only needs repairs when it is damaged by collisions or storms—accidents of infrequent occurrence.

But the timber that is above water, and which forms the superstructure, is in a situation very unfavorable to its durability. Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired, otherwise it might give way in a severe storm and great damage result to the whole structure. The cost of the superstructure of the kind used here is about $11 a running foot. There is now 606 feet of it here that is more than twelve years old. It needs renewal, and will cost $6,666. This sum is not included in the amount required to complete the existing project.

Name of harbor, Charlotte, N. Y. Collection district, Genesee, N. Y. (at Charlotte). A fixed light of the fourth order on crib 380 feet inside of outer end of west pier; a range light of three fixed lights, 2 red and 1 white, 60 feet high, at inner end of west pier. Forts Niagara and Ontario, N. Y., are the nearest works of defense.

Money statement.

July 1, 1894, balance unexpended	$2,631.64
Amount appropriated by act of August 17, 1894	15,000.00
	17,631.64
June 30, 1895, amount expended during fiscal year	9,062.78
July 1, 1895, balance unexpended	8,568.86
July 1, 1895, outstanding liabilities	691.56
July 1, 1895, balance available	7,877.30
Amount (estimated) required for completion of existing project	94,650.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	75,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Arrivals and departures of vessels at Charlotte Harbor, New York, during fiscal year ending June 30, 1895.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	636	114,302	55	10,264	95	30,323
Foreign	190	82,242	218	41,057	140	48,453
Total	826	196,544	273	51,321	235	78,776
American owned	638	113,884	18	2,081	151	55,383
Canadian owned	188	82,660	255	49,240	84	23,393

Sum total, 1,334 arrivals; 326,641 registered tonnage.

Arrivals and departures of vessels at Charlotte Harbor, New York, etc.—Continued.

DEPARTURES.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home	632	114,376	48	7,740	79	25,089
Foreign	118	80,180	224	43,569	162	55,466
Total	820	194,556	272	51,309	241	80,555

Sum total, 1,333 departures; 326,520 registered tonnage.

Greatest draft of vessels	feet	15
Greatest tonnage of vessels	registered tonnage	1,150
Greatest load of vessels	net tons	1,680

Receipts and shipments by lake at Charlotte Harbor, New York, during fiscal year ending June 30, 1895.

Trade.	Receipts.					Shipments.			
	Passengers.	Merchandise.	Poles and ties.	Posts and wood.	Lumber, etc.	Passengers.	Merchandise.	Oil.	Coal.
		Net tons.	*Net tons.*	*Net tons.*	*Net tons.*		*Net tons.*	*Net tons.*	*Net tons.*
Home, on lake	10,374	.....	.....	.....	.....	12,553	23	.....	163,625
Foreign, on lake	9,905	56	3,465	5,596	937	7,657	102	118	206,360
Total	20,279	56	3,465	5,596	937	20,210	125	118	369,985

Navigation closed December 8, 1894; navigation opened April 15, 1895. Total revenue collected at port during fiscal year, $3,150.

For the purpose of reduction to tons weight the following is assumed, viz: Seven barrels of oil equal 1 ton; 20 crates of fruit equal 1 ton; 4 live animals equal 1 ton; 1,000 feet lumber equal 1½ tons; 1 cord wood and posts equal 1½ tons; 12 railroad ties and poles equal 1 ton.

O O 2.

IMPROVEMENT OF HARBOR AT PULTNEYVILLE, NEW YORK.

OBJECT.

To furnish a protected channel of navigable width and not less than 10 feet depth at the mouth of Salmon Creek, Wayne County, N. Y., which is situated 21 miles east of the Genesee River.

PROJECT.

The present project of 1872 provides for a breakwater running 330 feet eastward from the west side of the creek, a west pier or jetty thence northward into the lake, and an east pier or jetty about 200 feet eastward from the west pier and parallel to it; also a dredged channel between the piers and behind the breakwater and extending about 400 feet up the creek.

After this work was done, at a total expenditure of $71,000, it was found that the waves from the lake when driven by a gale from the northwest would strike the east pier in such a way as to be reflected upon the beach within the harbor, and that in receding they would sweep the gravel and sand from the beach into the excavated channel along the harbor side of the breakwater, where it would lodge across the mouth of the creek.

Accordingly, it was further proposed, in 1884, in order to make dredging of permanent value and effect, to build a sand-tight structure 500 feet in total length parallel to the breakwater and about 100 feet from it, between it and the harbor beach, so as to arrest this movement of material.

A part of this structure was built in 1892.

The following appropriations have been made for this work:

May 23, 1828, an act appropriating for survey of shore between Oswego and Charlotte with a view to improvement of harbors $400.00

July 11, 1870	$5,000	June 14, 1880	$3,000
March 3, 1871	5,000	March 3, 1881	2,000
June 10, 1872	10,000	August 2, 1882	4,000
March 3, 1873	10,000	September 19, 1890	2,000
June 23, 1874	10,000	July 13, 1892	1,000
March 3, 1875	10,000	August 17, 1894	1,500
August 14, 1876	3,000		
June 18, 1878	5,000	Total	75,500
March 3, 1879	4,000		

PRESENT WORKS.

West breakwater.—This has a total length of 330 feet, and is formed as follows:

Section A, from the west shore line eastward 150 feet in length and 15 feet in width, formed by cribs of flatted round logs built at local expense before the General Government undertook the improvement of the harbor in 1867, $30,000 having been thus expended before that year. It was last repaired by the United States in 1877, but is now in a half-ruined condition. It received some trifling repairs in 1893.

Section B, 180 feet long, built by the United States in 1871, has not since been repaired, and is very much decayed above water level.

West pier.—Has a total length of 558½ feet, and consists of the following parts:

Section A, 222 feet long, built in 1874–75, and not since repaired.

Section B, 93½ feet long, built in 1880; no subsequent repairs. Section C, 183 feet long, built in 1881, and repaired slightly in 1884. Section D, 60 feet long, forms the end of this pier, built in 1883; not since repaired. The outer end has been breached and much stone has escaped. It will soon be destroyed unless the end is rebuilt.

East pier.—This has a total length of 571½ feet. It was built between the years 1872 and 1880, and consists of the following parts:

Section A, beginning 140 feet from the shore line (at the end of a private wharf, since destroyed) and extending 85½ feet northward into the lake. It was built in 1880, and has not since been repaired.

Section B, 62 feet long, built in 1877, and not since repaired.

Section C, 30 feet long, built in 1877, and not since repaired.

Section D, 92 feet long, built in 1872, and not since repaired.

Section E, 180 feet long, built in 1872, and not since repaired.

Section F, 122 feet long, built in 1873, and not since repaired.

In all these sections the cribs are sound, but the superstructure needs renewal, without which the whole will be wrecked.

Sheet piling.—Of the structure to arrest sand drift from the harbor beach to the channel into the creek, which was proposed in 1884, 200 linear feet, from the east side of the creek outlet eastward toward the land end of the east jetty, was built in 1891–92. The structure is sand tight, being formed of the Wakefield patent sheet piling. Its oak wale pieces are below the line of no decay, and they are tied back by iron rods to logs buried in the bottom, upon which the accretion will probably form, so that the structure may be expected to be a permanent one. It of itself produced an effect in causing a scour of the shoal between it and the breakwater, but dredging was necessary to make a navigable channel. Experience shows that this bulkhead is not wholly efficient in its incomplete condition.

Sufficient piling of the kind used is now on hand to extend the bulkhead 100 feet. It seems desirable to continue to extend it, in accordance with the project, as rapidly as the money supplied will allow.

CHANNEL.

Dredging was done in 1873, 1875, 1880, and 1893 to secure a channel of navigable width and about 9 feet depth between the jetties along the west breakwater and several hundred feet up the creek. The channel was not permanent throughout its length, but at two or three points it shoaled rapidly, particularly at the mouth of the creek, at the entrance to the inner harbor. Here the depth, in every case, was soon reduced to 2 or 3 feet. This was due to the washing of sand from the harbor beach by waves that struck the shore obliquely.

It was to stop this drift of material that the sand-tight bulkhead was erected. The fact that it of itself caused a deepening of this portion of the channel encourages the belief that it will fully protect the cut that has since been formed by dredging. The bulkhead, however, is hardly long enough, being only about 200 feet in length, and there is still some shoaling to the east of it, near the shoulder angle of the breakwater.

OPERATIONS.

Operations have been limited to the preparation of a sufficient quantity of tongued and grooved piling, made under the Wakefield patent, to extend the sand-tight bulkhead 100 feet. The piles are 16 feet long and 6 inches thick, being formed of three oak planks of the proper length, and each 12 inches wide and 2 inches thick. One hundred of these piles cost $410. There was also expended during the year $55.59 for engineering and office expenses.

REMARKS.

The entire superstructure of the works at this place is in a most wretched condition. The marvel is that it has held together so long. One thousand four hundred and sixty linear feet of piers and jetties have been built here by the United States, all of which is valuable and necessary to the maintenance of the harbor. As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below the general level of the water is not subject to decay and only needs repairs when it is damaged by collisions or storms—accidents of infrequent occurrence. But the timber that is above water, and which forms

the superstructure, is in a situation very unfavorable to its durability. Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired, otherwise it might give way in a severe storm and great damage result to the whole structure. The cost of the superstructure of the kind used here is about $11 a running foot.

All of this superstructure is more than twelve years old and most of it is over twenty. It will cost to renew it $15,000, in round numbers.

This sum is not included in the amount given as required to complete the existing project.

Name of harbor, Pultneyville, N. Y. Collection district, Genesee, N. Y. Nearest light-house, Great Sodus, N. Y. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1894, balance unexpended	$24.67
Amount appropriated by act of August 17, 1894	1,500.00
	1,524.67
June 30, 1895, amount expended during fiscal year	476.57
July 1, 1895, balance unexpended	1,048.10
Amount (estimated) required for completion of existing project	7,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	7,500.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Arrivals and Departures of vessels at Pultneyville, N. Y., during fiscal year ending June 30, 1895.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.	
	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	9	734	20	411
Foreign, on lake	.....	.....	9	292
Totals	9	734	29	703
American owned	9	734	13	402
Canadian owned	.....	.....	16	301

Sum total, 38 arrivals; 1,437 registered tonnage.

DEPARTURES.

Home, on lake	9	734	13	402
Foreign, on lake	.....	.....	16	301
Total	9	734	29	703

Sum total, 38 departures; 1,437 registered tonnage.

Greatest draft of vessel	feet..	8½
Greatest tonnage of vessel	registered tonnage..	76
Greatest load of vessel (lumber and merchandise)	tons..	75

Receipts and shipments by lake at Pultneyville Harbor, New York, during fiscal year ending June 30, 1895.

Trade.	Receipts.				Shipments.		
	Passengers.	Merchandise.	Lumber, etc.	Post and wood.	Passengers.	Fruit.	Merchandise.
		Net Tons.	*Tons.*	*Tons.*		*Tons.*	*Tons.*
Home, on lake	238	10	.....	.....	48	8	.....
Foreign, on lake	.....	10	69	254	.....	15	.....
Total	238	20	69	254	48	23	.....

For the purpose of reduction to tons weight, the following is assumed, viz: Seven barrels of oil equal 1 ton; 1,000 feet of lumber equal 1½ tons; 20 crates of fruit equal 1 ton; 12 railroad ties and poles equal 1 ton; 1 cord wood and posts equal 1½ tons; 4 live animals equal 1 ton.

Navigation closed November 13, 1894; navigation opened May 16, 1895.

O O 3.

IMPROVEMENT OF HARBOR AT GREAT SODUS BAY, NEW YORK.

OBJECT.

To secure a navigable channel from Lake Ontario to Great Sodus Bay with a depth of 15 feet.

Great Sodas Bay is 5 miles long, 2 to 3 miles wide, is deep and landlocked, and is situated midway between Oswego and the Genesee River. It is the coal-shipping port on Lake Ontario for the Pennsylvania Railroad.

PROJECT.

1828.—To contract the entrance to Great Sodus Bay to 470 feet by breakwaters extending from east and west shores and to define and protect a channel 470 feet wide by piers extending to deep water in Lake Ontario.

1882.—To extend the piers to the 15-foot curve in the lake and to dredge the channel between them to 15 feet depth at extreme low water.

The following appropriations have been made for this work:

May 23, 1828, an act appropriating for survey of shore between Charlotte and Oswego with a view to improvement of harbors $400.00

March 2, 1829	$12,500.00	June 23, 1874	$15,000.00
March 3, 1829	15,280.00	March 3, 1875	10,000.00
March 2, 1831	17,450.00	August 14, 1876	5,000.00
February 24, 1832	17,000.00	June 18, 1878	5,000.00
March 2, 1833	15,000.00	March 3, 1879	2,000.00
June 28, 1834	15,000.00	June 14, 1880	3,000.00
March 3, 1835	11,790 00	March 3, 1881	5,000.00
July 2, 1836	12,600.00	August 2, 1882	25,000.00
March 3, 1837	12,000.00	July 5, 1884	10,000.00
July 7, 1838	10,000.00	August 5, 1886	16,875.00
June 11, 1844	5,000.00	August 10, 1888	24,000.00
August 20, 1852	10,000.00	September 19, 1890	10,000.00
June 23, 1866	53,151.80	July 13, 1892	15,000.00
March 2, 1867	80,000.00	August 17, 1894	15,000.00
July 11, 1870	5,000.00		
June 10, 1872	15,000.00	Total	467,646.80

PRESENT WORKS.

The project has been completed, except that the east jetty lacks 800 feet of reaching the curve of 15 feet at extreme low water, and that the channel has not been dredged to 15 feet for its full width.

The dredging formerly done at this place (which has been quite large in amount) was all done parallel to and near the west jetty. The drifting sand upon this side of the jetties has formed an enormous deposit, building out the shore in front of the west breakwater and against the west jetty. This sand is carried over the jetty by the wind, and perhaps through it to some extent by the waves, and in this manner has found its way to the channel.

It is estimated that not less than 142,000 cubic yards of sand was carried into the space between the jetties from 1870 to 1892. Most of the sand falls near the west jetty at its inner end. Therefore the dredging done last year was upon a line crossing the channel diagonally from the outer end of the west jetty to the inner end of the east one. It is found that this work is more permanent.

The piers and jetties which contract the entrance and define and shelter the channel were originally built in 1829–1834. They were started from the west and east sides of the entrance, naturally about 4,000 feet wide, and were extended toward the center, where they were continued northward by parallel jetties, 470 feet apart across the 8-foot bar, from deep water in the bay to deep water in the lake.

These piers and jetties, defining and sheltering the channel, were built in 1829–1834, and were composed of cribs of timber, each 18 feet wide and 30 feet long, sunk end to end upon the natural sand and gravel bottom in as close contact as practicable by filling them with loose stones.

The cribs were formed of logs hewed flat, framed together and bolted with iron driftbolts and wooden treenails. They appear to have had floors of slabs, and were allowed to settle into the natural sandy bottom for part of the season before building upon them the continuous superstructure of hewed timber. These old cribs, in part or whole, are still in place and are sound below mean water level.

The different portions of the work may be described as follows:

West breakwater.—This has a total length of 2,200 feet. It was built 18 feet wide, with a superstructure of same width, in 1829–1834.

The cribs were each 18 feet wide and 30 feet long, and starting at the beach line gradually increased in depth to 8 feet, where they joined the jetty.

Section A, 1,693 feet long from the west shore eastward, built in 1829–1834, has never been repaired and was long since covered by the accretion of the beach, and its maintenance is now unnecessary.

Section B, 241 feet long, built in 1829–1834. It has never been repaired by the United States and its condition is the same as the preceding section. Its superstructure was, however, repaired by the owner of the adjacent land in 1888.

Section C, 266 feet long, built in 1829–1834 and last repaired in 1877–78.

West jetty.—This is 1,580 feet long and is 18 to 20 feet wide, as follows:

Section A, from the shoulder angle northward, 975 feet, built in 1829–1834, and last repaired in 1877 and 1880.

Section B, 285 feet long, built in 1829–1834, and last repaired in 1889.

Section C, 134 feet long, built in 1869, and last repaired in 1889.

Section D, 185 feet long, built in 1883. It has received no general repairs since, but in 1891 it was renewed at the outer end in consequence of injuries it had received from a barge striking it.

East breakwater.—This has a total length of 1,651 feet from Charles Point, on the east side of the bay, westward to join the east jetty. It is made up as follows:

Section A, from Charles Point westward 215 feet, built in 1884, and not since repaired.

Section B, 511 feet long, built in 1829–1834, and last repaired in 1887–88.

Section C, 415 feet long, built in 1829–1834, and last repaired in 1887–88.

Section D, 172 feet long, built in 1829–1834, and last repaired in 1894.

Section E, 264 feet long, built in 1829–1834, westward 81 feet, repaired in 1891, the remainder in 1894.

Section F, 74 feet long, to east jetty, built in 1829–1834, and last repaired in 1891.

East jetty.—This is 1,294 feet long, from its junction with the east breakwater northward to the 10½-foot curve of extreme low water in the lake. Its details are as follows:

Section A, from the angle of the breakwater 440 feet northward, built in 1829–1834, and last repaired in 1891.

Section B, 500 feet long, built in 1834, last repaired in 1890.

Section C, 154 feet long, built in 1883, and not since repaired.

Section D, 200 feet long, built in 1885, and not since repaired.

In 1877 50 running feet of sheet piling was driven along the west jetty northward from a point 150 feet north of the shoulder angle with a view to make it sand-tight. In 1887–88 this work was extended 612 feet. It all consists of 4 by 12 inch oak plank, 20 feet long, strengthened by a 6 by 12 inch oak wale piece, bolted through into the crib timbers.

To arrest sand movement into the channel there was also built in 1877 and 1880 upon the west sand beach, where it has formed again against the west jetty, a system of overlapping sand-catch fences of a total length of 760 feet. These fences have been effective, but they can not be maintained beyond high-water line, and there is generally a wide space of sand between them and the water, from which the prevailing westerly wind blows the sand across the jetty. This is the source from which comes a considerable portion of the sand which tends to refill the channel.

These fences are not very durable and are troublesome to keep in repair, and an effort has been made to induce a growth of willow trees which will in time take the place of the fences. About 800 good-sized trees were planted in the spring of 1893. A recent inspection shows that they are nearly all alive and have made good growth.

CHANNEL.

1829.—The space, 470 feet wide, between the jetties had a natural depth of 8 feet in October, 1829. This was the actual depth at that time, when the water level must have been at least 1 foot and was probably 2 feet above extreme low water, this being the average stage of lake level at this time of year. No plane of reference of lake level was established until 1838, when the present accepted extreme low-water level was determined at Oswego and fixed as the zero of the gauge, whose readings have since been daily observed in feet and hundredths

above this zero. The record of channel depths in the various reports are much confused during recent years as well as formerly by variously stating the depths as at ordinary low-water level, or at ordinary water level, or as the actual depth at a given date. In this report all such reference will be reduced to the plane of extreme low-water level without comment.

1836.—The first dredging was done at Great Sodus Harbor in 1836 and was continued during 1837 and 1838, $45,390 being thus expended.

1838.—The result was to form a channel 100 feet wide, 1,500 feet long, with 11½ feet depth, by removing about 30,000 cubic yards of gravel and sand.

1844.—In August, 1844, this channel was found to have shoaled to 9 feet depth.

1856.—The next dredging was done in 1856, when 6,233 cubic yards of sand was removed, at a cost not stated.

1867.—Nothing more was done until 1867, when renewal of the jetty was begun and dredging was done under its shelter; 9,200 cubic yards were then dredged, at 24 cents per cubic yard.

1868-69.—The dredging was continued in 1868 and 1869, completing a channel by removing about 40,000 cubic yards additional.

1870.—In 1870 the sand had again drifted into this 200-foot channel to such an extent as to reduce it to 8 feet depth for its west half and 4 to 5 feet depth for its east half, the undredged eastern 270 feet of the space between the jetties varying from 2 feet at the inner end to 7 feet at the outer end.

1873.—In 1873 19,000 cubic yards of sand was removed, at 35 cents per cubic yard, measured in position, again making the channel 9 feet deep for 150 feet next the west jetty, and this was continued in—

1874.—By removing 44,977 cubic yards of sand, at 22½ cents per cubic yard scow measurement, and again making the 200 foot channel 9 to 11 feet deep.

1881.—No further dredging was done until 1881, when the channel had again shoaled to a governing depth of 8 feet, and dredging was resumed.

1882.—During 1881 and 1882 42,050 cubic yards was removed, at 23 cents per cubic yard, in scows, making a channel 2,300 feet long, 120 feet wide next the west jetty, and 11½ feet deep.

1886.—In 1886 dredging was again needed and 13,224 cubic yards were removed, at 16 cents per cubic yard, making a channel 50 feet wide and 12 feet deep.

1887.—In 1887 the depth was again reduced to 9 feet and a centrifugal pump was employed to take the sand from the channel and deliver it on the other side of the west jetty. Thirteen thousand cubic yards of sand were thus removed, at 12½ cents per cubic yard, making 10¼ feet depth for 50 feet width.

1889-90.—In 1889 and 1890 a dipper dredge was again employed; 40,942 cubic yards of sand, gravel, and cobblestones were removed, at 18 cents per cubic yard, scow measurement, and a navigable channel was again made 100 feet in width, 2,000 feet long, and 15 feet deep, located 30 feet from the west jetty.

1892.—In 1892 this cut had again shoaled to 8¾ feet, and the United States dredging plant was employed during the month of June in deepening it. Eleven thousand two hundred and nineteen cubic yards of sand were removed at this time.

1893 —During the fiscal year ending June 30, 1894, 94,071 cubic yards have been removed along the new line hereafter described; 50,106 cubic

yards, scow measurement, was dredged under contract, at 11½ cents per cubic yard, and the remainder by the plant owned by the United States at about the same actual cost.

All of this serves to show that the channel has been a troublesome one to maintain, and this, as before stated, has been largely due to the extensive beach to the westward, from which the sand is carried by the wind over the jetty and dropped into the channel. A comparison of the results of a survey made in 1870 with those of another similar survey made in 1892 by the same assistant engineer indicates that not less than 142,000 cubic yards of sand has found its way into the channel in this manner. This would be at the rate of about 6,500 cubic yards a year, which does not seem an unreasonable amount to one who has seen the clouds of sand that are lifted by every westerly gale. In 1877–1880 sand fences were erected to stop this drift. They have no doubt been of considerable service, but it has not been possible at all times to keep them in thorough repair and they are not sufficient in extent to entirely effect their purpose.

In 1893 about 800 good-sized willow trees were planted, and it is hoped that as they grow they will prove much more durable and efficient than the sand fences.

Owing to this tendency of the channel to fill up near the inner end of the west jetty, all dredging subsequent to 1892 has been upon a line that runs diagonally from the outer end of the west jetty to the inner end of the east one.

OPERATIONS.

Under the approved project the superstructure has been renewed on 355 feet of the east breakwater, being that portion known as Section D, 172 feet long, and the eastern 183 feet of Section E. The parapet form was used on all but the most easterly 10 feet, where the low form was used to join with the work of 1878.

The work was done by hired labor. It was begun on the 20th of September and finished at the end of November. It cost for filled work—that is to say, for everything except engineering and office expenses—$3,305.55, or at the rate of $9.28 per running foot. The dredging plant was also docked for the first time since it was built in 1891 and thoroughly repaired. The cost being defrayed from the appropriations for improving the harbor at Charlotte and Great Sodus Bay in equal proportions: The amount from this appropriation being $994.36.

The total expenditure from this appropriation for office, engineering contingencies, traveling expenses, etc., was $1,247.42.

REMARKS.

In regard to this channel I think that the piers should be extended to the 15-foot depth as rapidly as possible, and the channel should be dredged to its full width in the manner before described.

It is proper to invite attention to the fact that the United States has constructed some 6,725 linear feet of jetties and breakwaters at this place, of which 4,800 feet is valuable and necessary to the maintenance of the harbor. The rest has been absorbed by the advance of the shore line, and further repairs to it will probably not be required.

Six thousand eight hundred feet in round numbers, of jetty work, therefore, must be kept in good order. As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below water is not subject to decay and only needs repairs when it is injured by collisions or storms, accidents of infrequent occurrence.

But the timber which is above water and which forms the superstructure is in a situation very unfavorable to its durability. Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired, otherwise it is liable to give way in a severe storm and great damage result to the whole structure.

The cost of the superstructure of the kind used here is about $11 a running foot. There is now 1,581 feet of it here that is from eleven to eighteen years old. It needs renewal now, and will cost $18,000. This sum is not included in the amount required to complete the existing project.

Name of harbor, Great Sodus Bay, New York. Collection district, Oswego, N. Y. Nearest light-house, Big Sodus, New York; a fixed white light of the fourth order, varied by a white flash every two minutes, on a bluff three-fifths mile west of the entrance to the bay; a fixed white light of the sixth order, 180 feet inside of the outer end of the west pier, and a fixed red light of the sixth order, at elbow of west pier. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1894, balance unexpended	$31.99
Amount appropriated by act of August 17, 1894	15,000.00
	15,031.99
June 30, 1895, amount expended during fiscal year	5,547.33
July 1, 1895, balance unexpended	9,484.66
Amount (estimated) required for completion of existing project	28,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	28,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels at Great Sodus Harbor, New York, during fiscal year ending June 30, 1895.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	94	5,700	51	2,304	28	9,122
Foreign, on lake	13	774	24	3,515	47	18,580
Total	107	6,474	75	5,819	75	27,702
American owned	87	5,359	47	1,611	14	3,674
Canadian owned	20	1,115	28	4,208	60	23,938

Sum total, 238 arrivals; 39,755 registered tonnage.

DEPARTURES.

Home, on lake	87	5,359	47	1,611	14	3,674
Foreign, on lake	20	1,115	28	4,208	60	23,938
Total	107	6,474	75	5,819	74	27,612

Sum total, 237 departures; 39,665 registered tonnage.

Greatest draft of vessel	feet..	12
Greatest tonnage of vessel	registered tonnage..	541
Greatest load of vessel	net tons..	1,344

Receipts and shipments, Great Sodus Harbor, New York, during fiscal year ending June 30, 1895.

Trade.	Receipts.				Shipments.		
	Passengers.	Grain.	Poles and railroad ties.	Lumber.	Passengers.	Coal.	Posts and wood.
		Net tons.	*Tons.*	*Tons.*		*Net tons.*	*Net tons.*
Home, on lake	2,004	85	.....	.....	2,071	12,601	376
Foreign, on lake	.....	620	170	201	.....	63,418	.....
Total	2,004	705	170	201	2,071	76,019	376

Navigation closed November 29, 1894; navigation opened April 24, 1895.

For the purpose of reduction to tons weight the following is assumed, viz: Seven barrels of oil equal 1 ton; 1,000 feet lumber equal 1½ tons; 20 crates fruit equal 1 ton; 12 railroad ties and poles equal 1 ton; 1 cord wood and posts equal 1½ tons; 4 live animals equal 1 ton.

O O 4.

IMPROVEMENT OF HARBOR AT LITTLE SODUS BAY, NEW YORK.

OBJECT.

To secure a channel from Lake Ontario into Little Sodus Bay of navigable width and of depth not less than 15 feet at extreme low water.

Little Sodus Bay is 2 miles long, three-fourths of a mile wide, is deep and landlocked, and is situated midway between Oswego and Great Sodus, or 13 miles west of Oswego. It is the coal-shipping port on Lake Ontario for the Lehigh Valley Railroad.

PROJECT.

To contract by breakwaters the entrance to the bay to a width of 250 feet and maintain a channel 200 feet wide and 15 feet deep at extreme low water by parallel piers.

The following appropriations have been made for this work:

May 23, 1828, an act appropriating (for survey of shore between Charlotte and Oswego, with a view to improvement of harbors) $400.00

August 20, 1852	$10,000.00	June 18, 1878	$10,000.00
April 9, 1864	1,778.36	March 3, 1879	5,000.00
April 9, 1864	2,224.00	June 14, 1880	20,000.00
April 9, 1864	99.00	March 3, 1881	20,000.00
June 23, 1866	33,840.41	August 2, 1882	25,000.00
March 2, 1867	50,000.00	July 5, 1884	10,000.00
April 10, 1869	1,500.00	August 5, 1886	12,500.00
July 11, 1870	5,000.00	August 10, 1888	16,000.00
March 3, 1871	15,000.00	September 19, 1890	13,000.00
June 10, 1872	15,000.00	July 13, 1892	6,000.00
March 3, 1873	15,000.00	August 17, 1894	8,000.00
June 23, 1874	15,000.00		
March 3, 1875	10,000.00	Total	324,941.77
August 14, 1876	5,000.00		

PRESENT WORKS.

The project has been completed, except that the west and the east jetties lack 200 feet and 465 feet, respectively, of reaching the 15-foot curve, and that the whole of the channel between the jetties has not been dredged to 15 feet, 12 feet at extreme low water being the governing depth.

A narrow channel was dredged through the hardpan bar last fall, in which there is a depth of not less than 15 feet at low water. This channel is about 40 feet wide, and is parallel to the west jetty and about 30 feet from it.

With this exception, the undredged part of the channel is the outer 500 feet of the space between the present jetties and 200 feet additional beyond the end of the west jetty. The material is tough hardpan, probably requiring blasting before it can be dredged.

The breakwaters and jetties which contract the entrance and define and shelter the channel were begun in 1854, though the works now forming the harbor were built since 1867. They consist of crib-work breakwaters extended from the west and the east sides of the entrance (naturally 2,500 feet wide in 1867) upon the gravel bar which is characteristic of this and of all the bays on the south shore of Lake Ontario.

The breakwaters were built to the sides of the natural cut through the bar (which was 1¼ feet deep in 1853 and 5½ feet deep in 1866) and were thence extended north to deep water in the lake by parallel jetties 250 feet apart.

These structures were formed of cribs each 20 feet wide and 30 feet long, sunk end to end upon the natural bottom in as close contact as practicable by filling them with loose stone gathered from the shores of the bay and lake and by dredging gravel and dumping it into them.

The cribs were formed of sawed hemlock timber 12 inches square and 10 by 12 inches, which was framed together and bolted with iron drift-bolts. The cribs had tight plank floors, and the earlier ones were allowed to settle into the natural gravel and sand bottom for part of the season before building the continuous superstructure of 12 by 12 inch pine timber, also filled with loose stone. For the later cribs a foundation was prepared by dredging a trench or by depositing riprap.

At each side of the bay the junction of the breakwater with the shore was effected by stake and fascine structures intended to aid the accretion of drift.

The different portions of the work are described as follows. In every case where depth of water is mentioned in this report the depth at extreme low-water level or at the zero of the Oswego gauge is meant.

(*1*) *West breakwater.*—The original structure was built in 1868, and was a peculiar one, specially designed for this place. It was of triangular cross section, with 13 feet base and 13 feet sides, built in separate sections, 25 feet long, of 6 by 6 inch hemlock frames, planked inside with 2-inch hemlock plank, the whole filled with loose stone and sunk upon the crest of the bar at a depth of from one-half foot to 2 feet. Its total length from the west shore to the west jetty was 650 feet. The breakwater was built in 1868 and was destroyed the same year.

In 1870–71 the present rectangular crib-work structure, 469 feet long and 10 feet wide, was built 30 feet outside of and parallel with the original one. It is still in place, though much decayed. All but 90 feet adjoining the west jetty is buried beneath the accretion of the west beach, and this 90 feet was repaired in 1887. Since then the beach has extended out in front of it 100 feet, and it probably will not need further repair.

(*2*) *West pier or jetty.*—This is 1,960 feet long and 20 feet wide, extending across the bar north to deep water in the lake. The structure is made up of the following parts:

Section A, 186 feet long, which was built in 1854. It has never been repaired. A beach having formed outside of it, it is no longer neces sary to maintain.

Section B, 50 feet long, built in 1854, last repaired in 1867.
Section C, 860 feet long, built in 1867–68, last repaired in 1889.
Section D, 150 feet long, built in 1870–71, last repaired in 1889–90.
Section E, 242 feet long, built in 1881, has not been repaired.
Section F, 272 feet long, built in 1883, has not been repaired.
Section G, 200 feet long, built in 1885, has not been repaired.

(3) *East breakwater.*—This is 1,850 feet long, mainly consisting of 1,680 feet of shallow crib work, which is 20 feet wide, placed upon the crown of the bar in depth varying from half a foot above extreme low water to 2½ feet below the same plane. It extends from near the east side of the bay to the east jetty, its junction with the east shore being effected by 170 feet of stake-and-fascine work. Its details are as follows:

Section A is 170 feet long and 8 feet wide, and was built in 1885 from the east shore to the crib-work breakwater, which it joins 50 feet west of the east end.

It consists of stakes and wire-bound fascines made from the trunks and branches of hard-wood brush, the whole paved with stone gathered from the lake shore. It has stood without attention and is covered by the accretion of sand and gravel.

Section B is 150 feet long and 20 feet wide, and was built in 1878, forming the east end of the breakwater. It has not since been renewed, except its western 50 feet, which was included in the portion rebuilt in parapet form in 1891.

Section C, 750 feet long, built in 1875, last repaired in 1891.
Section D, 540 feet long, built in 1874, last repaired in 1889–90.
Section E, 240 feet long, built in 1873, last repaired in 1889–90.

(4) *East jetty.*—This is 1,510 feet long from the west end of east breakwater across the bar to 11½ feet of water in the lake. It is parallel to the west jetty, and 250 feet from it. The details are as follows:

Section A, 512 feet long, built in 1872–73, last repaired in 1887.
Section B, 757 feet long, built in 1881–82, has not been repaired.
Section C, 241 feet long, built in 1883, has not been repaired.
Section D. This jetty still lacks about 500 feet of its proposed length.

A full history of this work was published in the Annual Report of the Chief of Engineers for 1892.

CHANNEL.

Prior to beginning the construction of jetties there was no permanent natural channel across the bar which closed the entrance to the bay.

The general width of this bar from deep water within the bay to deep water in the lake outside was from 600 to 900 feet between 6-foot curves, about 2,000 feet between 12-foot curves, and 2,600 feet between 15-foot curves. These and all depths stated in this report are at extreme low-water level, which coincides with the plane of zero of the Oswego gauge, which was established at extreme low-water level in 1838.

The natural depths upon the crest of the bar and in the channel across it varied from time to time.

In 1828 and in 1845 the crest of the bar was above water for most of the distance across the bay, the channel (at the same place as the present one) being stated in the Annual Report for 1847 to have but 2 feet of water. If this meant the actual depth, which seems probable, its reduction to extreme low-water level would give but half a foot.

In 1853, just before the first jetty construction, the depth was 1¼ feet below extreme low water, which was in 1854 increased by dredging under the shelter of the west jetty to 6 feet.

The amount of material then removed to make the channel, which appears to have been about 450 feet long and 80 feet wide, must have been about 4,000 cubic yards.

In 1866, when the work of improvement was begun, a detailed survey showed this cut to be 5½ feet deep.

Dredging in the channel was resorted to in 1868–69, and again in 1871, and sufficient material was removed from the channel to secure a depth of 10 feet between the jetties.

In 1875 a shoal about 100 feet wide had formed across the channel by sand drift around the outer end of the west jetty which then extended only to the 9-foot curve. This shoal had 8 feet depth and 1,592 cubic yards was dredged from it, at 25 cents per cubic yard, to make a passage 80 feet wide next to the west jetty. An exceptionally high stage of water prevailed in the lake in 1876, and no further dredging was done until 1879, when deepening the channel to 15 feet depth at extreme low water was begun. During 1879, 1880, and 1881 there were removed 25,931 cubic yards of gravel, sand, and mud, at 18 cents per cubic yard, scow measurement, and the work was continued in 1881, at 17¾ cents per yard. At the latter rate 43,562 cubic yards, scow measurement, were removed up to December 1, 1881, making 15 feet depth at extreme low water for 200 feet width and 1,700 feet in length. This carried the excavation out as far as the west jetty then extended, 242 feet beyond the light-house pierhead. The jetty was extended 472 feet farther in 1883 and 1885, but no attempt was made to extend the excavated channel, as the fact was developed that the material composing the remainder of the bar was a tough hardpan, instead of gravel and sand as the rest had been, and money for its removal was not available, 20,000 cubic yards being the excavation required to make 15 feet depth, the estimated cost being $1 per cubic yard.

In 1891 the space between the jetties had gradually shoaled to about 12 feet by the deposit of loose sand and mud.

In 1891, 7,257 cubic yards of sand and 541 cubic yards of hardpan were removed from between the jetties by the United States dredging plant, and in 1893, 12,590 cubic yards of sand and 1,777 yards of hardpan were removed by the same means, with the result, as before stated, of making a narrow channel of the required depth through the hardpan bar to deep water in the lake.

In 1893 work was continued with the United States dredging plant. Surface blasting was resorted to, to assist the dredge in breaking up the hardpan.

High-grade Atlas powder was used in charges of 25 pounds. It was feared that larger charges would injure the jetties. The cartridges that made up the charge were placed together in a bag, sunk to the bottom in the proper place, and fired by an electric exploder. The explosions all seemed to be sharp and complete, and the water tamping, owing to the stage of the lake, was about 14 feet. Nevertheless, the effect on the bottom seemed to be almost nothing. The material was just about as hard to dig as before, and careful soundings made immediately after a shot failed to reveal even a moderate depression at the point where the charge had rested.

An Ingersoll steam rock drill was then mounted on a scow and sent to Little Sodus to try the effect of the explosive when fired in drilled

holes. Great difficulty was experienced in drilling, owing to the tool very frequently becoming jammed between the hard round bowlders that were thickly embedded in the hardpan. Many delays also occurred from bad weather, for most of the work had to be done outside the shelter of the jetties, and a very moderate sea on the lake was sufficient to stop drilling. However, some 85 holes about 5 feet deep and 8 or 10 feet apart were drilled and fired along the proposed cut. The charge used was about 5 pounds to the hole. The material was undoubtedly loosened somewhat by these shots, but the effect was less than one would have expected; less, certainly, than it would have been in ordinary rock.

During the time it was employed the dredge removed 12,500 cubic yards of sand and 1,777 cubic yards of hard material from the channel.

OPERATIONS.

No active operations were had during the season. A contract has been entered into with Edward J. Hingston, of Buffalo, N. Y., for the removal of about 10,000 cubic yards of hard material from the channel between the jetties and beyond them to deep water in the lake. The contract price is 47 cents a cubic yard, measured in place. It is required that a least depth of 15 feet at extreme low water shall be secured, and nothing is to be paid for material taken from below this depth.

A careful survey of the channel has been made, and it is found that the present contract will suffice for the excavation of a cut of the required depth and 136 feet wide through the hardpan bar. This work will be completed during the present season. There will still remain a considerable quantity of sand to be removed from the inner end of the jetty channel, but the work will be much less costly than the removal of the hardpan.

REMARKS.

The completion of the project requires about 665 linear feet of jetty extension and the dredging of some 8,500 cubic yards of hard material. As all the material from the outer end of the jetties to the 15-foot curve in the lake appears to be hardpan, it is reasonable to expect that a cut once dredged through it would remain open, unless it was filled by sand moving out beyond the ends of the jetties from the beach.

There is no evidence that the beach sand is moved out as far as this. Even if the sand does move out and deposit in the cut in moderate quantities, it might be cheaper to maintain the channel by occasional dredging than it would be to keep the increased length of jetties in repair.

It is proper to invite attention to the fact that the United States has constructed some 5,789 linear feet of jetties and breakwaters at this place, of which 4,904 feet is valuable and necessary to the maintenance of the harbor. The rest has been absorbed by the advance of the shore line, and further repairs to it will probably not be required.

Four thousand nine hundred feet of jetty work, in round numbers, therefore, must be kept in good order. As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below the water is not subject to decay and only needs repairs when it is injured by collisions or storms—accidents of infrequent occurrence.

But the timber which is above water and which forms the superstructure is in a situation very unfavorable to its durability. Its

useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired; otherwise it is liable to give way in a severe storm and great damage result to the whole structure.

The cost of the superstructure of the kind used here is about $11 a running foot. There is now 1,692 feet of it here that is from twelve to seventeen years old. It needs renewal now, and will cost $19,000. This sum is not included in the amount required to complete the existing project.

Name of harbor, Little Sodus Bay, New York. Collection district, Oswego, N. Y. Nearest light-house, Fair Haven, N. Y.; a fixed white light of the fourth order near the head of the west pier, a fog bell attached to a mast range light at the inner end of west pier. Nearest work of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1894, balance unexpended	$122.16
Amount appropriated by act of August 17, 1894	8,000.00
	8,122.16
June 30, 1895, amount expended during fiscal year	953.33
July 1, 1895, balance unexpended	7,168.83
Amount (estimated) required for completion of existing project	44,500.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	40,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Arrivals and departures of vessels at Little Sodus Harbor, New York, during fiscal year ending June 30, 1895.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	47	2,931	18	1,775	29	9,609
Foreign, on lake	10	604	76	12,632	51	17,110
Total	57	3,535	94	14,407	80	26,719
American owned	48	2,960	20	1,664	29	9,372
Canadian owned	10	583	74	12,743	51	17,347

Sum total, 231 arrivals; 44,661 registered tonnage.

DEPARTURES.

Home, on lake	47	2,770	14	661	28	9,257
Foreign, on lake	11	773	76	13,714	52	17,462
Total	58	3,543	90	14,375	80	26,719

Sum total, 228 departures; 44,637 registered tonnage.

Greatest draft of vessel	feet..	12½
Greatest tonnage of vessel	registered tonnage..	588
Greatest load of vessel	net tons..	856

Receipts and shipments at Little Sodus Harbor, New York, during fiscal year ending June 30, 1895.

Trade.	Receipts.					Shipments.		
	Passengers.	Merchandise.	Fish.	Posts.	Lumber, etc.	Passengers.	Merchandise.	Coal.
		Net tons.	*Net tons.*	*Tons.*	*Tons.*		*Net tons.*	*Net tons.*
Home, on lake	10	.....	.....	.....	.....	8	4	2,752
Foreign, on lake	.....	294	5	196	72	.....	28	60,244
Total	10	294	5	196	72	8	32	62,996

Navigation closed November 22, 1894; navigation opened May 1, 1895.

For the purpose of reduction to tons weight, the following is assumed, viz: Seven barrels of oil equal 1 ton; 1,000 feet of lumber equal 1½ ton; 20 crates of fruit equal 1 ton; 12 railroad ties and poles equal 1 ton; 1 cord of wood and posts equal 1½ ton; 4 live animals equal 1 ton.

O O 5.

IMPROVEMENT OF HARBOR AT OSWEGO, NEW YORK.

OBJECT.

To provide a basin sufficient for the needs of commerce at the mouth of the Oswego River, New York, on Lake Ontario, and to secure and maintain a navigable channel into said basin and river.

PROJECT.

1827.—To inclose by breakwaters a western basin of 11 acres area outside the bulkhead line, and an eastern basin of 9 acres outside the bulkhead line, and to protect the entrance channel by piers. (Completed 1829; pier extended 1869.)

1870.—To inclose by a breakwater of crib work filled with stone a western basin of 100 acres area outside the 9-foot curve and the existing western breakwater. (Completed in 1882.)

1882.—To build an eastern breakwater on the alignment of the western, sheltering an eastern basin. But little work was done upon this structure, and in 1888 this portion of the project was abandoned and the few cribs that had been sunk were removed.

1883.—To build spurs projecting from lake face of western breakwater, for the purpose of breaking the accumulated and reflex waves occasioned by that breakwater, which have rendered the entrance exceptionally difficult and dangerous during storms. (Completed in 1889.)

1891.—To make permanent and to shelter the western entrance to the outer harbor.

1893.—To improve the inner harbor by the removal of rock, so as to afford a depth of 15 feet at extreme low water for a distance of several hundred feet up the river.

The following appropriations have been made for this work:

March 20, 1826	$200.00	April 10, 1869, allotment	$22,275.00
March 2, 1827	33,348.64	April 10, 1869, allotment	6,000.00
May 19, 1828	9,583.39	July 11, 1870	50,000.00
March 3, 1829	7,472.00	March 3, 1871	100,000.00
March 2, 1831	2,812.92	June 10, 1872	100,000.00
March 2, 1831	18,600.00	March 3, 1873	100,000.00
March 2, 1831	519.00	June 23, 1874	75,000.00
March 2, 1831	84.92	March 3, 1875	90,000.00
February 24, 1832	19,000.00	August 14, 1876	90,000.00
March 2, 1833	8,400.00	June 18, 1878	90,000.00
June 28, 1834	30,000.00	March 3, 1879	90,000.00
July 2, 1836	20,000.00	June 14, 1880	90,000.00
March 3, 1837	15,000.00	March 3, 1881	50,000.00
July 7, 1838	46,067.00	August 2, 1882	80,000.00
June 11, 1844	20,000.00	July 5, 1884	80,000.00
August 20, 1852	40,000.00	August 6, 1886	71,250.00
August, 1860, allotment transferred from light-house	30,000.00	August 10, 1888	100,000.00
		September 19, 1890	30,000.00
June 28, 1864, allotment	25,000.00	July 13, 1892	40,000.00
June 23, 1866	45,000.00	August 17, 1894	37,000.00
March 2, 1867	60,000.00		
July 25, 1868, allotment	20,000.00	Total	1,842,612.87

PRESENT WORKS.

The present works consist of—

(1) The inner west breakwater, which lies wholly within the outer breakwater, by which it has been superseded.

(2) The inner east breakwater, which has been private property since 1852.

(3) The fort wharf, which constitutes a storage place for harbor material.

(4) The outer west breakwater, whose maintenance constitutes the principal work.

(5) The detached spurs outside the outer breakwater, two of which have been built and of which two more are proposed to shelter the present western opening.

(6) The deepening of the entrance and river channel in the inner harbor.

These works are described as follows:

(*1*) *The inner west breakwater.*—This is 1,993 feet long, of masonry and crib work of various widths, and was built between 1827 and 1837. It is composed of the following parts:

Section A, the shore arm, is 250 feet long, 30 feet wide, and has a crib-work base, built in 1828, with superstructure reconstructed of cut lime-stone masonry, in parapet form, in 1837–38. In fair preservation.

Section B, from the angle eastward, 110 feet. The same description as the last, except that its condition is ruinous.

Section C, located back of Section B, overlapping it and extending past it a distance of 138.8 feet, including a 10-foot passage for boats cut through its east end in 1884. This section is of crib work, 22 feet wide, built back of the ruined masonry structure in 1854. Its superstructure was rebuilt on its south or harbor face in 1887 and on its lake face in 1891. It serves to shelter the United States reservation slip, where the United States boats, scows, and dredge are moored, and to provide storage places for timber needed for repairs.

Section D is 838.2 feet long, in prolongation of the line of the masonry portion of the lake arm eastward, and extends to the light-house pier-head. It was built in 1828–29, and its superstructure was rebuilt and

repaired in 1844, 1854, 1860, 1867, and 1874, and was burned in the great fire of 1881. It was transferred to the Light-House Department in 1886 and was rebuilt by the Light-House Department in 1889 in parapet form. The superstructure is built of 12 by 12 inch pine timber, filled with loose stone and decked with 3-inch pine plank. It is 27 feet wide, founded upon the original crib work, 30 feet wide. At the west end of this section a small crib-work jetty was built in 1892, 12 feet wide and 48 feet long, to shelter the passageway for boats from the outer to the inner harbor. The jetty is formed of a piece of parapet and of old timber from the 1884 breach in the outer breakwater, and its superstructure is of blocks of stone taken from the adjoining lake bottom. A bridge crosses the passageway high enough to permit the passage of the Life-Saving Service boat at extreme high water.

Section E is the light-house pierhead, of irregular form, extending 92 feet on prolongation of the line of the breakwater and 132 feet at a right angle to it northward. Upon a mass of loose stone, inclosed by the cribs forming the pierhead substructure, stands the masonry light-house which was built in 1836. The cribs were built in 1835, and its superstructure was repaired and rebuilt repeatedly until the transfer to the Light-House Department in 1886, by which Department it was last repaired in 1889.

Section F is 432 feet long in prolongation northward into the lake of the pierhead, and is 30 feet wide. It is not included in the transfer to the Light-House Department. It was built in 1869–1871, and is now undergoing thorough repair for the first time.

(2) *The inner east breakwater.*—This is 750 feet long and 30 feet wide and is located on the prolongation eastward of the line of the inner west breakwater, from whose pierhead it is distant 357 feet. The Oswego River flows between them into the lake.

From this point the breakwater extends to the east shore beneath Fort Ontario. It was built in 1828–29 in the same manner as the west breakwater. It was repaired in 1844, and in 1852 was transferred to Gerrit Smith, esq., whose estate since 1852 has owned and maintained it, building under its shelter wharf property which for many years was very valuable, but which is now not so much used as formerly. In consequence, the breakwater has not been properly maintained for some years past, and it is now in a damaged state.

(3) *The fort wharf.*—This is the landing in the inner harbor for Fort Ontario, and forms a part of the United States reservation pertaining to that fortification. It has been of value in connection with the harbor improvement as a storage place for timber and stone and for framing and launching cribs. It has a water front of about 250 feet, with an area of about 100 by 200 feet. The crib work forming its water front was built in 1839, when the fort was built, was repaired in 1863, when the fort was reconstructed, and has recently been repaired above line of no decay for use on the harbor work. It is now in good order.

(4) *Outer west breakwater.*—This is 6,033 feet long, inclosing 100 acres outside the 9-foot curve of what was formerly the open lake, in front of the city and of the inner harbor. It starts from the lake shore nearly a mile westward from the river outlet and extends eastward upon a line generally parallel to the lake front and 1,200 feet from it to a point opposite the entrance to the inner harbor. The breakwater is formed of timber crib work filled with loose stone, and is 35 feet wide throughout.

Its substructure is formed of cribs, each 35 feet long and 35 feet wide, a few of those built last being of double this length. Its superstruc-

ture is also timber, and is now in parapet form. Its height on the shore arm is 9⅓ feet above extreme low-water level; on the lake arm, 13⅓ feet.

The original survey for the location of this breakwater was made in September, 1869, the plan was approved by the Board of Engineers March 30, 1870, and the work of construction was begun on July 5, 1871. It was completed in July, 1882. Its details are as follows, all of the cribs being built upon essentially the same plan as those of the shore arm next described.

The shore arm is 916⅓ feet long, from a ledge of rock forming the shore northeastward into the lake to 18 feet depth at extreme low water.

Section A from the shore 846⅓ feet was built in 1871–72 of cribs, each 35 feet long and wide, sunk in contact with each upon the natural bottom, the cribs being built to fit the irregular ledges of rock on which most of them were placed. The cribs were formed of 12 by 12 inch hemlock timber, all the sticks being of the same length—35 feet.

The continuous superstructure built the same season upon these cribs was formed of 12 by 12 inch pine timber, seven courses in height, with horizontal deck 8 feet above extreme low water, of 3-inch pine plank laid crosswise, 3 inches apart, upon 6 by 12 inch pine joists, loose stone of random sizes being filled in to the top of the joists. The planks were fastened by 9-inch by one-half inch spikes and by six longitudinal bands of 2 by one-half inch flat iron. The deck was maintained by annual repairs of varying extent every year from the first until the rebuilding of the superstructure upon a radically different model in 1887. It has required no repairs since.

Section B is 70 feet long in prolongation of the last section to the angle of the lake arm. It was built in 1871–72, at the same time and in the same manner as the last section. Its superstructure had the same frequent repairs until 1884, when, with the following section, the superstructure was renewed in parapet form of the 1884 model.

It received some repairs during the year 1892, and the superstructure on the exposed face needs repairs below water.

Section C of the lake arm is 2,910 feet long from the angle eastward. Points upon the lake arm are described by naming their distances from the angle, measuring along the axis. It was built in 1872–1877 of cribs, each 35 feet long and 35 feet wide, of depths varying from 18 to 30 feet. The cribs were sunk upon the natural bottom of the lake and about thirty of the first ones settled more or less irregularly into the sand. The bottom upon which the rest stood was of stone and gravel, and very little settlement took place, generally about 1 to 2 feet on the lake face.

In 1884 the entire superstructure was renewed in parapet form. On December 8, 1884, the waves of an exceptionally severe northwest gale drove 140 feet of the superstructure through into the harbor, with parts of the substructure down to 9 feet depth, leaving bulkheads at each side of the break.

The opening thus made through the breakwater caused so marked an improvement in the sanitary condition of the inclosed space within the harbor and was so convenient an entrance for vessels and tugs that it has not been rebuilt and will be made a permanent opening. Since the building of the 1884 parapet upon this section of 2,910 feet it has received damage at many points and has had considerable repair, though much less than required by the original flat superstructure.

The part of the breakwater which is in a condition needing close attention, and which may need radical repairs, is that near the 1884 breach. The actual breach was limited, as above described, to 140 feet, and it has not since extended. But the superstructure was strained and its

joints opened for 100 feet farther on each side, and it has only been maintained by closely watching it and putting in screw bolts and steel plates to check indicated yielding. The exposed face of all the cribs of the substructure below water from the angle eastward for about 700 feet (including the 140-foot breach) is more or less shaken and shows signs of weakness.

Section D is 570 feet long, in prolongation of the last section eastward. It was built in 1877–1879, with its cribs placed upon the natural bottom, some being double the usual length, and with continuous superstructure, which was 8 feet high, with a flat deck. The superstructure received repairs at various times, and in 1890–91 it was renewed in parapet form, in connection with the following section.

Section E is 900 feet long, in continuation of the lake arm. Its cribs were built in 1880 and differ from all the preceding ones in that they had a foundation prepared by dredging a trench in the natural sand bottom 3 to 6 feet deep and 55 feet wide and then filling it with random stone. Its superstructure was renewed, with that of the last section, in 1891.

Section F is 490 feet long, in continuation of the lake arm to the eastern angle. The cribs were built in 1880–1882 and founded upon random stone placed in a trench 3 to 10 feet deep and 55 feet wide. The cribs were about 18 feet deep, and the original superstructure was built eight courses high, with a flat deck. In 1884 the parapet superstructure was built upon the other, all of white pine, without the creosote in the deck and supports which was used in Section C.

It was damaged by a schooner which was wrecked against the breakwater in 1885, but the shaken timbers held together until 1891, when the injury was repaired in an effective manner by screw-bolting a large steel plate to the face, below water, and filling back of it with grout of clear cement. In 1894 the cement had washed out through bolt holes in the plate. These were stopped with iron and the space refilled with Portland-cement mortar.

This carries the description to the east end of the lake arm, where the channel arm extends southward, inclosing the beacon crib.

Section G, the channel arm, is 246 feet long from the south side of the lake arm, with which it makes about a right angle and extends inward. It was built in 1882, its cribs being placed upon a foundation of randon stone, filling a trench dredged 4 to 10 feet in the natural sand bottom, where the depth of water was 20 feet and the sand 15 or more feet deeper.

The superstructure on the first 62 feet next to the lake arm had originally a flat deck 6 feet above extreme low water, and the parapet was added in 1882, like that on the preceding section. The inner 184 feet has still the flat deck, but its change to parapet form is part of the project. Its inner angle was cut into 12 feet below water by a barge in 1891, requiring extensive repairs.

The detached spurs.—Under the project of 1883 two or more detached spurs outside of the outer breakwater were provided for. Of these, two have been built—one, situated 250 feet west of the eastern end of the breakwater, was built in 1885; the other, situated midway of the length of the breakwater, was built in 1889. The first one consists of a single crib 100 feet long, 40 feet wide, and 25 feet deep, with 4-inch close floors 4 feet above the bottom and with vertical sides to mean water level. It is placed with its long axis at a right angle to the face of the breakwater and is separated from the latter by a space of 10 feet.

The natural bottom at the place was of sand 15 or more feet deep, and a trench was dug for each side and each end of the crib 10 feet deep and 15 feet wide at bottom, and this trench was filled with random stone.

The riprap base thus formed extended 10 feet outside of the crib line all around. It was leveled at 21 feet below extreme low water and the crib sunk upon it. It was undermined by the wave action along the west face, and in 1888 the west side had settled to 7 or 8 feet lower than the east side. It now stands in this position. Large amounts of dredge material—stone, gravel, etc.—have been deposited along the west side, filling it up to 10 feet depth, and the structure appears secure from further settlement. It has not since been repaired.

The second detached spur, built in 1889, was located 2,600 feet westward of the eastern end of the breakwater, about midway of its length. It also is placed with its long axis at a right angle to the breakwater face, from which a 10-foot space separates it. Its length is 150 feet, with a bottom width of 40 feet, a surface width of 26½ feet, and a top width of 14 feet.

The sides slope regularly from 5 feet above the bottom to the top of the superstructure. It has not since been repaired.

It now needs some additional stone filling, as a recent examination shows that the upper portion is empty, probably due to settlement of its filling.

HARBOR DREDGING AND RIVER CHANNEL.

1847.—The first dredging of which there is record was done in 1847, when a gravel bar which had formed across the river channel, apparently about 1,000 feet inside the breakwater, was removed at private expense.

1855.—The next was in 1855, when the United States dredge, under direction of the engineer in charge, was engaged in deepening the entrance to the river near the head of the upper island at the expense of the city.

1861.—This dredge was sold in 1861 for lack of funds to maintain it. No other dredging is reported up to this date and it is not likely that any had been done, as the harbor and its entrance had a general depth in excess of the draft of the lake vessels.

1866–1869.—In 1866 the inner harbor adjoining the west breakwater was too shoal to accommodate the increased draft of vessels to 12 feet, and its dredging was commenced. The quantity and price of excavation is not stated, but $29,451 was thus expended to June 30, 1867, when about $12,000 was estimated as the cost of completing it. The work was continued and finished in 1868 and 1869, 12 feet depth at extreme low-water level being reported in the west inner harbor.

1881.—No further dredging was done until June, 1881, when work under contract was begun for deepening the river channel from the entrance near the light-house to the head of the island at the foot of Schuyler street, for a length of 1,426 feet and a width of 125 feet. This deepened to 15 feet below extreme low-water level the west half of the river channel, outward from the south line of Schuyler street, excepting a small area next the upper island wharf, where bed rock prevented dredging below 12 feet.

Twenty-three thousand one hundred and ninety-two cubic yards, at 70 cents per yard in scows, was removed in 1881. The material taken out was gravel and stone, with many large pieces of bed rock brought down by ice from the river bed in the rapids above the city, the thick-

ness of the layer worked upon by the dredge varying from 1 to 6 feet. Before beginning work many borings were made in the area to be worked upon, to determine whether the channel could be made. Bed rock, with 12 feet depth, was found beneath the loose deposit, extending out 50 feet into the channel from the east and west island wharves, just north of Schuyler street. No attempt was made to remove this.

1883–84.—In September, 1883, dredging was resumed to deepen the east half of the channel. This was done at 30 cents per cubic yard in scows, and was completed in July, 1884; 34,123 cubic yards was removed. The material consisted of gravel, stone, and rock, and was dumped upon the prolongation eastward of the line of the east breakwater to serve as a foundation for the proposed eastern extension of that work. The depth which was made in the channel increased from 15 feet at the upper end to 17 feet at the lower end to allow for rise and fall of waves.

1883.—In 1883, without cost to the United States, there was also dredged from the inner west harbor 5,000 cubic yards of gravel for wharf filling.

1887.—Up to this time the draft of vessels had been limited to 12 feet by the depth that could pass the Welland Canal, but in 1887 this was increased to 14 feet, and the inner harbor, above the limit of the 1884 dredging, was too shallow, except at a high stage of the lake.

1890.—During 1890 and 1891 rock excavation to 16 feet depth was done at private cost to extend the channel above described up to the Marine elevator (the most northern one on the east side) and to the New York, Ontario and Western Railroad coal trestle on the upper east island wharf. This at once increased the available depth of the harbor to 16 feet, and large steamers came to use it before the work was fully complete.

1891.—In 1891 the clearing off of loose material from the bed rock was continued by the United States up to the north line of Cayuga street, a farther distance of 900 feet for 240 feet width, leaving undredged 100 feet next the wharves on each side. Over this area the effective depth was increased 2 or 3 feet, the rock shoaling from 15 feet at the north end of the work to 7½ feet at the south end. Sixteen thousand eight hundred and forty-five cubic yards was removed, at 23½ cents, in scows. In addition, there were many pieces of ledge rock which the dredge could not raise which were taken out by the United States hired labor, with a derrick boat. The aggregate was about 78 cubic yards, costing an average of $7.58 per yard. After completing this the ridges of gravel and stones were leveled off by dragging a bar of railroad iron over the bottom.

1892.—In 1892 the United Slates dredge was employed to remove a ridge of sand 20 to 50 feet wide which had formed in the outer harbor along the harbor face of the outer breakwater by the material washed over and through it. This work began at Station 3075 and extended thence westward to Station 1400. The deposit had reduced the original depth of about 17 feet to 10 or 12 feet, and its removal required the dredging of 10,010 cubic yards, including 385 cubic yards of stone crib filling which was saved. The dredge also reopened in 1892 the boat passage which was originally dredged through the inner old breakwater to the outer harbor in 1884.

1893.—The act of Congress approved March 3, 1893, authorized the unexpended balance of the current appropriation to be applied to the removal of rock within the harbor lines to a uniform depth; and in pursuance thereof 3,170 cubic yards of solid rock, measured in place,

was drilled, blasted, and removed, at a cost of $8,957.50. During the same season a dredging plant was hired for one hundred and thirty one and one-half hours to remove a shoal near the light-house at the entrance to the inner harbor; 2,806 cubic yards of gravel and loose stone was removed at a total cost of $986.25.

1892, 1893, 1894, 1895.—The private work referred to under head of 1890 has been continued more or less each year since then. In 1893 the rock excavation was thus extended along the front of the North-western elevator property on the west side of the river to accommodate the largest steamers, and in 1894–95 it was extended on the east side in the trestle basin, to give deep water along the whole length of the recent New York, Ontario and Western Railroad Company's coal trestle and also to give deep-water access to the Delaware and Hudson Canal Company's coal trestle which has not heretofore had this advantage, and which has been rebuilt and extended during 1895.

1894 and 1895.—The act of Congress approved August 17, 1894, authorized the extension of the rock excavation by the expenditure of $10,000, and in pursuance thereof 3,351 cubic yards of solid rock, measured in place, was drilled, blasted, and removed at a cost of $9,215.25.

This extended the work 93 feet farther upstream, with a width of 392 feet and a depth of 15 feet below extreme low water, to agree with the 1893 work. This was mainly done in 1894 and was completed in 1895.

OPERATIONS.

The execution of the project approved August 27, 1894, for the removal of about 3,000 cubic yards of solid rock from the inner harbor near the river mouth begun on September 20, 1894, was continued until December 20, when it was suspended for the winter; being resumed in the spring and completed on May 20, 1895.

The object of this improvement was to extend the deep area in this portion of the harbor, where work was begun in 1893, and to secure a uniform depth of not less than 15 feet at low water, which would enable vessels of this draft to reach certain grain elevators and coal trestles at any stage of the lake.

The firm of Hingston, Rogers & O'Brien, of Buffalo, N. Y., were hired to do this work. They were paid $2.75 per cubic yard, measured in place, for all rock removed from within the given area. No payment was made for rock which it was necessary to remove below the 15-foot plane in order to secure the required depth throughout, nor for any loose material that was lying on top of the solid rock. The work was begun by the contractors on September 20, 1894, and completed in the following May; 3,351 cubic yards of solid rock was removed by drilling, blasting, and dredging. The cost of this work was $9,215.25.

The result of this work was to extend the deep water about 93 feet farther up the river. It ought to be extended farther, but even as it is the effect has been very beneficial to the commerce of Oswego, by causing a yearly increase in the number of large-class vessels which come to the harbor.

The deep area now extends from the lake to a line across the river 83 feet north of the north line of Seneca street.

To extend this depth 200 feet farther upstream will require the removal of a layer of rock 4 feet thick.

The most important construction work undertaken during the year was the repair of the breach in the outer breakwater, for which special provision had been made in the last appropriation bill. The execution

of this work necessitated the complete removal down to the grillage foundation of a partially wrecked section of the breakwater 35 feet in length, the construction and sinking in place of a new crib, and the rebuilding of a corresponding length of new superstructure thoroughly bonded into the adjacent work. The lateness of the season at which the appropriation became available and the very exposed locality of the work rendered the undertaking a particularly hazardous one and required some novel expedients to be resorted to in order to bring it to a successful conclusion.

The work was begun in September, 1894, and finished in the succeeding December. For a detailed description of the work, the difficulties encountered, and the manner in which they were overcome I would invite attention to the accompanying report of Assistant Engineer Judson, who was in local charge of this work and to whom much credit is due for its successful accomplishment without accident or loss.

The total cost of the work was $10,774.16, but in this cost is included the value of certain stone, iron, lumber, and other material on hand. The actual amount of money disbursed for the purpose was somewhat less, but the balance of the $10,000 will be used to replace the material taken from stock.

In addition to the work of repairing of this breach other repairs were made to the outer breakwater at various localities as they were required.

Total amount expended for this purpose in money and material	$876.11
Expended for engineering and office expenses and contingencies	2,173.12
For removal of rock in the inner harbor	9,215.25
For services of watchmen, for gauge reading, and for the care and repair of plant	2,183.68
For repairs upon the outer breakwater, as above described	9,780.67

REMARKS.

The need of an east breakwater or jetty to protect the harbor from waves formed by northeasterly storms and to render the entrance at all times safe and easy is appreciated more and more with each succeeding year. In recognition of this want Congress, in an act approved March 3, 1895, authorized a survey to be made and called for a project and estimate for the construction of an east breakwater or jetty at the mouth of the Oswego River for the protection of commerce and to render the entrance to it easy and safe.

In compliance with this requirement a survey has been made and a plan involving the construction of a curved jetty 1,400 feet in length and costing in round numbers $197,000, or an average of $137.50 a running foot, was prepared and submitted.

As no appropriation has yet been made for the construction of this jetty it can not be treated as a portion of the existing project. Its cost, therefore, does not appear in the money statement in giving the amount required for completion of the existing project.

The present project permits the break 140 feet long in the outer breakwater near the shore arm to be left open, and proposes the construction of two properly located spur cribs to protect the entrance.

The cribs adjacent to the break are considerably shaken and need extensive repairs, and the spur cribs should be built as soon as possible.

The whole work will cost about $75,000.

It is proper to invite attention to the fact that the United States has constructed some 8,776 linear feet of piers and breakwaters at this place, of which 6,465 feet is valuable and necessary to the maintenance

of the harbor. The rest has been superseded by the construction of new breakwater or disposed of to other departments of the Government or to private individuals, and further repairs to it will probably not be required. Six thousand eight hundred feet of pier work, in round numbers, therefore, must be kept in good order. As elsewhere explained, it is composed of timber cribs filled with stone. The part that is below water is not subject to decay, and only needs repairs when it is impaired by collisions or storms—accidents of infrequent occurrence. But the timber which is above water and which forms the superstructure is in a situation very unfavorable to its durability. Its useful life is from twelve to fifteen years. It is not wholly decayed at the end of this period, but it ought to be renewed before its strength is too much impaired, otherwise it is liable to give way in a severe storm and great damage result to the whole structure.

The cost of the superstructure of the kind used here is about $40 a running foot. There is now 3,716 feet of it here that is from twelve to seventeen years old. It needs renewal now, and will cost $150,000. This sum is not included in the amount required to complete the existing project.

Name of harbor, Oswego, N. Y. Collection district, Oswego, N. Y. Nearest lighthouse, Oswego, N. Y.; a fixed white light of the third order at the eastern end of the old west breakwater; a fixed red light of the fourth order on the eastern end of the outer west breakwater, with a fog bell attached. Nearest works of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1894, balance unexpended	$5,522.58
Amount appropriated by act of August 17, 1894	37,000.00
	42,522.58
June 30, 1895, amount expended during fiscal year	23,248.72
July 1, 1895, balance unexpended	19,273.86
July 1, 1895, outstanding liabilities	27.25
July 1, 1895, balance available	19,246.61
Amount (estimated) required for completion of existing project	85,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	85,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., June 8, 1895.

GENERAL: In compliance with instructions contained in the Department letter of March 14, 1895, I have the honor to submit the following project for the construction of an east breakwater or jetty at the mouth of the Oswego River for the protection of the harbor and to render the entrance to it easy and safe.

The project and the survey upon which it is founded was authorized by the sundry civil act approved March 2, 1895. The results of the survey are shown upon the accompanying map.

The original project for improving the harbor at Oswego was adopted in 1826 and provided for the construction of an eastern and a western breakwater on opposite sides of the river at its mouth. This project was soon completed, and though the works were difficult and expensive of maintenance it sufficed for many years for the commerce of Oswego.

In 1870, in order to give better facilities to the rapidly increasing commerce of the port, a project was adopted for the construction of a large breakwater, protecting nearly a mile of lake shore just west of the river mouth. This breakwater has been built, but it does not completely shelter the harbor at all stages of the wind.

When, as not infrequently happens, a storm comes from the northeast the seas are carried into this outer harbor to such an extent as to make it unsafe or exceedingly inconvenient for a vessel to lie anywhere in the eastern half of it, which half is the better and most accessible of the two. To this condition is no doubt largely due the fact that wharves and docks have never been constructed in the eastern part of this harbor. But these northeasterly storm waves not only enter the outer harbor but also the inner harbor, lying within the river mouth. The waves, being confined by the vertical faces of the docks, travel far up the river, even as far as the bridge, and vessels are then unable to load at the elevators and the outer end of the coal trestles. The harbor is also a very difficult one for vessels to make under certain conditions of the wind. The most frequent and most violent gales come from the northwest, and a vessel coming down the lake and seeking to enter the harbor is obliged to round-to under conditions which make it very difficult and dangerous. As the vessel turns round the outer beacon it finds the wind, the current of the river, and the full force of the waves setting it toward the rocky shore under the fort.

A great many wrecks have occurred here and a great many lives have been lost. Hardly a year passes without one or more vessels being destroyed at this place. Herewith is transmitted a photograph showing two vessels which were carried ashore here and totally destroyed during two successive days in the month of November last.

Oswego is the most important harbor on Lake Ontario; its commerce is greater than that of all the other American ports put together. The value of the freight which annually enters and leaves the harbor is not less than $7,000,000. This harbor, which ought to be the most accessible, is regarded by all lake navigators as the most dangerous to enter, and it is greatly feared and dreaded by them, and this large and valuable freight, together with the vessels which carry it, are yearly jeopardized by the lack of a suitable work on the east side of the river which would facilitate the entrance of vessels and keep out the seas.

An extensive and expensive breakwater designed to afford increased harbor facilities at this place is, in my judgment, not required. There is ample space for growth and expansion adequate to accommodate a much greater commerce than now comes to the port, provided this space is properly sheltered from the northeast so that it could safely and conveniently be used at all stages of the weather. In view of the foregoing, I would respectfully submit the following project, namely:

The construction of a curved jetty as shown upon the drawing, this jetty to terminate upon the line of the outer breakwater prolonged and 500 feet from it, so as to leave an entrance into the harbor 500 feet wide. The curve of the jetty is the arc of a circle having a radius equal to 2,000 feet. The jetty starts in comparatively shallow water, near a point of rocks which extends out into the lake. A sufficient opening is left here to allow the circulation of water and to permit any floating object which the river might bring down to be carried out into the lake, and also to allow the passage of small boats and tugs.

The survey shows that the character of the bottom is excellent. It consists of either coarse gravel and shingle, practically incompressible, or of solid rock. The depth of water along the axis of the jetty is shown upon the map.

The style of construction proposed is similar to that used in the outer breakwater. Wherever the natural depth of the water is more than 20 feet it will be filled up by a riprap of loose stone to a height of 20 feet below low water, and upon this foundation the crib substructure will be sunk.

It is proposed to use cribs not less than 100 feet in length, and to adopt a mode of construction much stronger than any heretofore used on this lake, so that if it is ever found desirable to build a concrete top the substructure will be perfectly capable of supporting it.

For the first superstructure a design similar to that adopted and approved in 1890 for the outer breakwater will be used. But inasmuch as it is not intended or expected that any considerable number of vessels will use this jetty as a place to tie up to, the high parapet will only be used for a length of 500 feet along the outer end of the jetty. For the remainder of the distance a low form of parapet similar to that on the shore arm of the breakwater will be used. The details of construction of the proposed jetty are fully shown upon the accompanying drawing.

The structure will be composed of 300 linear feet of 17-course crib with low parapet and no riprap foundation, 600 feet of 22-course crib with low parapet and 4 feet of riprap foundation, and 535 feet of 22-course crib with high parapet and 4 feet of riprap foundation.

Estimated cost of 100 feet of 17-course crib.

Hemlock or spruce (15 courses), 113,800 feet, B. M., at $12	$1,365.60
Pine (top, 2 courses), 12,600 feet, B. M., at $18	226.80
Oak (posts), 14,300 feet, B. M., at $25	357.50
Total lumber in 100-foot crib, 140,700 feet, B. M.	
Labor, overseer and foreman, on 140,700 feet lumber, at $9 per M	1,266.30
Add 25 per cent to labor on account for effect of eight-hour law	316.50
Screw bolts, 12,860 pounds, at $1.85 per 100 pounds	213.90
Driftbolts, 3,400 pounds, at $1.65 per 100 pounds	56.10
Spike, 400 pounds, at $2.12 per 100 pounds	8.50
Stone filling, 1,740 cubic yards, at $1	1,740.00
Total for 100-foot 17-course crib	5,551.20

Nine-course superstructure per 100 feet without stone.

From office records	2,900.44
Stone filling, 540 cubic yards, at $1	540.00
Add 25 per cent to labor account for effect of eight-hour law	150.00
Total for 100-foot low superstructure	3,590.44
Total cost of 100 feet of 17-course crib with low parapet and without riprap foundation	9,141.64
Cost of 300 linear feet of same	27,424.92
Cost of 100 linear feet of 22-course crib with low parapet and 4-foot riprap foundation (for crib only):	
Hemlock or spruce (20 courses), 154,952 feet, B. M., at $12	1,857.02
Pine (top, 2 courses), 12,660 feet, B. M., at $18	227.88
Oak (posts), 18,480 feet, B. M., at $25	441.00
Total lumber, 186,092 feet, B. M.	
Labor, overseer and foreman, on 186,092 feet lumber, at $9 per M	1,674.83
Add 25 per cent to labor account for effect of eight-hour law	418.70
Screw bolts, 16,700 pounds, at $1.85 per 100 pounds	308.95
Driftbolts, 4,400 pounds, at $1.65 per 100 pounds	72.60
Spike, 560 pounds, at $2.12 per 100 pounds	11.87
Stone filling, 2,160 cubic yards, at $1	2,160.00
Total cost of 100-foot 22-course crib	7,172.85
Cost of 100 linear feet of riprap foundation (average height, 4 feet), 900 cubic yards, at $1	900.00

100 feet finished structure, consisting of 22-course crib, low parapet, and 4-foot riprap foundation:	
Cost of crib per 100 feet	$7,172.85
Cost of superstructure	3,590.44
Cost of riprap	900.00
Total	11,663.29
Cost of 600 feet	69,979.74
Cost of 100 linear feet of 13-course superstructure (from office records) without stone	3,536.72
Stone filling, 714 cubic yards, at $1	714.00
Add 25 per cent to labor account for effect of eight-hour law	198.00
Total for 13-course superstructure	4,448.72
Total cost of 100 feet of 22-course crib, high parapet, and riprap foundation, from foregoing	12,521.57
Cost of 535 feet of same	66,990.40
Total cost of field work of proposed structure, 1,435 feet in length	164,395.06
Add 20 per cent for all contingencies	32,879.01
Total	197,274.07

Or, in round numbers, the total cost of the finished work will be $197,000, or an average of $137.50 per running foot.

The various items already given which go to make up this total are determined from the office records, giving the cost of similar work heretofore constructed by hired labor.

The rather large percentage which is allowed for contingencies is rendered necessary by the fact that the cost taken was simply for the work in the field, and did not include the engineering and office expenses nor the contractor's profit, if the work was done by contract, nor did it include the loss due to delays resulting from small and irregular appropriations nor the possible loss of which there is always danger in the construction of such works, due to sudden storms, involving loss of stone or the injury and destruction of partially filled cribs.

I have the honor to be, very respectfully, your obedient servant,

DAN C. KINGMAN,
Capt. of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Division Engineer, Northeast Division.)

REPORT OF MR. WM. PIERSON JUDSON, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., June 30, 1895.

SIR: I have the honor to submit the following report regarding the operations between September and December, 1894, in repairing the 1893–94 breach in the outer breakwater of Oswego Harbor, which work was specially provided for in the river and harbor bill of August 17, 1894, in the following terms: "Ten thousand dollars shall be expended in repairing the breach recently made in the breakwater at Oswego, New York."

The work consisted in the removal from the center of the Oswego outer breakwater, 2,600 feet from its western angle, of a shattered section 35 feet in length, which had been four times breached and three times repaired, and the construction in its place of a stronger structure, both the old and the new constructions being of timber crib work filled with loose stone.

The conditions under which the work must be done were unusually difficult, and will be described.

The breakwater cribs had stood intact at this point (except renewal of their superstructure) from the time when built, in 1876, until 1889, when the spur crib, 150 feet long, was placed here outside the breakwater, separated from it by a space of 10 feet and extending out at right angles into the open lake 150 feet.

The presence of this projecting crib caused a concentration of wave force in the angle and against the breakwater adjoining it, and the first northwest gale, on December 28, 1889, made a breach through the timber superstructure of the breakwater at 6 to 10 feet above water, the repair of which, made in January, 1890, cost $2,530. A similar gale of February 5, 1890, caused another breach at the same place, but this time in the crib-work substructure 10 feet below water, which was also repaired in the same year at a cost of about $600.

This withstood the waves until the winter of 1891–92, when another submerged breach was made at the same place, but this time at the bottom of the crib substructure, 16 feet below extreme low-water level.

This was too deep to be repaired within the structure, as formerly, and a concrete block of 30 tons weight, when immersed, was formed within a water-tight timber mold 6 feet in height, 20 feet long, and 9 to 12 feet wide, and was placed outside in the open space between the end of the spur and the broken face of the breakwater. This was done in October, 1892, at a cost of $1,013.

To further secure the base of this and of the adjoining cribs, there was deposited as a riprap on the exposed side of the spur and along the breakwater near it the stone and rock excavated in the river channel during the season of 1893, reducing the depth, which naturally was 16 and 18 feet, to 10 and 12 feet.

The submerged concrete block and this riprap were effective in securing the base of the breakwater crib from further damage; but during the winter of 1892–93 the top of the same crib substructure was again carried away from water level 5 feet down for a length of 20 feet, leaving the superstructure and parapet without stone filling.

This was repaired in November, 1893, by filling the exposed compartments of the parapet and of the substructure from 4 feet below water to 12 feet above water with two tight boxes, each 10 feet square and 16 feet deep, filled with concrete and weighing 90 tons each.

The boxes were used so that the concrete could be formed in them above water and lowered into place, giving the concrete time to harden without being exposed to the action of waves, which were almost constant at this exposed location.

Two were completed, while a third was three times destroyed while in progress and was not finished.

The last gale loosened the entire side of the substructure and showed that the whole crib must be rebuilt from the bottom. The work then done had cost $2,448, and was effective in holding the shattered structure in place through the succeeding winter, but the opening in the lake face was so enlarged as to extend 7 feet below water and 5 feet above for the whole length of the substructure crib, viz, 35 feet.

Having been breached four times, in 1889, 1890, 1892, and 1893, as has been recounted, and repaired three times, at an aggregate cost of $6,591, it became evident that any further repair of this much-patched structure was useless, and the need for entire renewal in a construction much stronger than was needed elsewhere in the breakwater was the subject of a special verbal report by the officer in charge to the River and Harbor Committee of Congress on April 9, 1894.

This resulted in the insertion of the before-quoted paragraph in the river and harbor bill of August 17, 1894, setting aside $10,000 for this purpose.

The necessary authority for beginning the work was not received until August 29, at which late date the calm season, specially needed for this extremely exposed location, had passed, and it was considered doubtful if the removal of the shattered structure and the substitution of a new one could then be accomplished that year. It was necessary to take the risk, however, as the breach might be extended indefinitely if not rebuilt before the winter storms. Work was therefore begun August 29 upon a new crib, which was to be 35 feet square, 14 feet deep, and of a construction, the strength of which was estimated at more than tenfold that of the original structure, upon the base of which this new crib was to be placed. Some of the special features of the new structure were as follows: The bottom of the new crib was made of 12 by 12 inch hemlock timbers, edge bolted solidly together and fastened beneath the walls of the crib to vertical oak posts on all the faces and at the interior intersections of cross-tie walls.

The sides of the crib were held together and to the tie ends by screw bolts passing through vertical oak posts, which posts extended within the crib from the bottom of the crib to the top of the completed parapet, and were screw bolted to every tie and also to every course of the side. Each set of ties was built between a pair of 8 by 12 inch oak posts, while 12 by 12 inch oak posts were screw bolted to the sides midway between the tie ends on all faces. Driftbolts were only used to steady the

timbers in place, the real fastenings being screw bolts, whose developed tensile strength is probably twentyfold the frictional hold of the driftbolts ordinarily used.

The quantity of iron used in building the new crib and superstructure equaled 223 pounds per 1,000 feet, B. M., of the timber used, 60 per cent of this being screw bolts. Comparison in this respect with other parts of the breakwater will be useful.

The 1876 original crib substructure, which was breached and is now replaced, contained per 1,000 feet, B. M., of timber and plank, 89 pounds of iron, 1½ per cent of which were screw bolts, with no vertical posts.

The 1884 parapet superstructure, also now replaced at this point, 136 pounds of iron, no screw bolts, no posts.

The 1887 shore-arm superstructure, which has not been damaged nor needed any repair, 157 pounds of iron, 22 per cent screw bolts, with vertical posts.

The 1889 spur crib, which has has not been damaged nor needed any repairs, 150 pounds of iron, 75 per cent screw bolts, with vertical posts.

The 1890 parapet superstructure, which has the same clear record, 162 pounds of iron, 78 per cent screw bolts, with vertical posts.

Returning to the 1894 work, the sides and ties of the new crib were made of 12 by 12 inch white pine, except the upper six courses of the exposed face, which were of 12 by 12 inch white oak.

The superstructure, of 13 courses above water, was formed in the same way, except that the lower 7 courses were of oak. The filling of the one-third of the crib next its exposed face and of the superstructure and parapet above it was formed of massive blocks of limestone weighing 1 to 5 tons each and packed closely in position against the lake wall, some of these blocks being 10 feet long and reaching the full width of the parapet. These blocks pertain to the early history of the harbor, having been brought here from Chaumont between 1830 and 1837 to pave a riprap mole in front of the inner breakwater. They were recovered from their position in the now abandoned mole, at a cost of about $2 per cubic yard, and have proved of the greatest value in this present work, entirely preventing any loss of stone filling from the incomplete crib and superstructure during the repeated gales whose waves swept over and through the work while in progress.

The crib was completed in the harbor ready to sink on September 26. The clearing of the old crib out of the breach had been of necessity deferred until the new one was ready to take its place, the concentration of waves at this place being such that those raised by an ordinary fresh wind of 20 miles per hour would send waves over the 13-foot parapet sufficient to wash away workmen and material, while those caused by a northwest gale of 60 miles per hour repeatedly threw up dense columns of spray 50 feet square to a height of 120 feet.

Aside from the concentration of waves produced at this spot, it is known that the normal waves which occur off Oswego Harbor are of excessive size and force. In December, 1884, the writer made accurate measurements of waves at a point 1,000 feet to windward of the breakwater angle, where the waves were of normal size and unaffected by the breakwater. The measurements were made during a northwest gale having a recorded velocity at the breakwater of 78 miles per hour. The solid tops of many hundred waves, exclusive of their foam crests, were observed to have a height of 19 feet above still-water level within the harbor, while the wave valleys were 12 feet below the same level, making total wave fronts of 31 feet height, which moved at a speed of 34 to 40 miles per hour.

Dynamometers recorded a force of impact of 940 pounds per square foot at 8 feet above water level, at which height the first breach here described was afterwards made.

The conditions being favorable, on Sunday, October 7, the 90-ton concrete blocks were broken by dynamite and the dredge at once set at work to tear out the timberwork below water, a gang of workmen meantime cutting down the ends of the proposed opening above water and building temporary bulkheads at each side to prevent the open work from unraveling in storms which might arise.

One feature of the cost of the work was the imperative necessity of closing up all loose ends every night. Sometimes this temporary work was all taken out again the next morning, and sometimes it had to withstand waves for a week before the work could be resumed.

Sometimes only an hour's work could be done before the rising waves would make it necessary to again close it up, oil being freely used to windward of the place to still the waves and to defer the cessation of work as long as possible.

Life preservers with lines were constantly on hand, and close watch was kept of the waves to avoid having the workmen caught by them and to prevent their wasting time in looking out for themselves. Through these precautions, which were none too great, no man was washed overboard during the work and no timbers were displaced. The clearing of the cut begun by the dredge on the 7th and 8th was a much more difficult operation than was expected, and was interrupted by rough water on October 9, 10, 11, and part of 12 and 13, and all of the 14th to 18th. It was

resumed and completed on the 19th to a depth of 12 feet below zero, and the new crib was placed and filled to water line with ballast stone that night by the help of two Wells lights, which made work by night nearly as effective as by day.

The ordinary ballast stone used were in part those taken from the old crib by the dredge, and were fragments of 12 to 200 pounds each. Such comparatively small stones would readily be washed out of the crib by waves, so that the next two days were occupied in filling the upper 2 feet of the crib with the blocks of Chaumont limestone before referred to, which formed a massive pavement over which the waves could roll without injury to the crib or its filling. This paving was completed on October 22. It was considered certain that the new crib would be settled slightly by the first heavy waves, and it could not be rigidly bolted to the adjoining work until final settlement had occurred. It was therefore necessary to suspend further operations and to wait for a heavy northwest gale.

Twelve days of calm weather followed, and the expected gale did not occur until November 1. After this subsided, on November 2, the crib was found to have settled 2 inches, and the work of bonding was at once begun; but it was stopped again on the 3d by heavy seas, which continued during the 4th, 5th, and 6th.

The only injury done during this time was the breaking of one 12 by 12 inch vertical post and the washing into the harbor of three blocks of stone, 2 to 3 tons each, which had been left under the shelter of the 13-foot parapet adjoining the new crib. Three other blocks, one 2½ feet square on end and 10 feet long, were moved by the rush of water for 40 feet along the banquet deck and stopped on the counterfort which projects from the harbor face of the breakwater.

A three days' calm followed this gale and work was continued then and whenever the waves permitted.

The small space precluded the employment of more than a limited force, 15 carpenters and 40 laborers being the greatest number that could work to advantage after the crib had been put in place. November proved to be more than usually stormy and work was again prevented by waves on the 10th, 14th, 17th, 19th, 23d, 27th, and 28th. Oil was freely used to retard and prevent the breaking of waves and work went on without regard to spray or rain whenever the waves were not so large as to wash men and materials overboard.

For instance, on November 25 and also on November 26, when the wind and sea were heavy enough to wreck two vessels on the rocks east of the harbor entrance, work was continued on the breakwater without interruption.

To bond the new work securely into the adjoining old work the superstructure was stepped back at each side of the 35-foot crib so that when finished the new part was 102 feet long on parapet and 63 feet long on banquet.

On November 29 the breakwater was incased in a foot or more of ice, whose removal with tools, steam jet, and salt required several hours.

The work was finally decked and completed on December 3, and it now shows no effect of any kind from the gales of the past winter.

The following is an itemized statement of the cost:

Article.	Quantity.	Price per unit.	Total.
Dynamite to break concrete blocks.....pounds..	21	$0.20	$5.20
Dredge, removing old crib from break.....hours..	49.5	10.00	495.00
2 lighters, carrying ballast taken from breach and used to sink crib, days.....	33	8.00	264.00
Timber used in crib and superstructure (119,500 feet, B. M.):			
Hemlock.....feet, B. M..	15,000	13.00	195.00
Pine.....do....	76,000	18.85	1,432.60
Oak.....do....	28,500	24.70	703.95
Lumber (pattern).....do....	144	20.00	2.88
Iron used in crib and superstructure.....pounds..	26,552	.....	498.74
Screw bolts.....do....	16,102	.0185	.....
Driftbolts.....do....	4,214	.0225	.....
Do.....do....	5,040	.0165	.....
Spike.....do....	1,030	.0212	.....
Lag screws.....do....	166	.0225	.....
Oak shear pins.....	260	.025	6.50
Tallow, to launch crib.....pounds..	50	.08	4.00
Stone ballast to fill crib and superstructure (700 cubic yards):			
On hand.....cubic yards..	100	.....	100.00
Purchased.....do....	278.8	.....	278.82
Taken from old crib.....do....	201.2	.....	240.00
Blocks from old mole, cost of recovery.....do....	120	.....	
Oil (crude) to reduce waves.....barrels..	2.1	.....	10.37
Oil (refined) for light.....do....	1	.....	5.83
Salt to remove ice.....do....	4	.90	3.60
Tug hire.....hours..	142	5.00	710.00
Services of overseer, 12 to 16 carpenters, and 40 to 65 laborers..months..	3	.....	5,817.67
Total.....	.....	.....	10,774.16

It is believed that the difficulty which has heretofore existed in maintaining the breakwater at this most exposed point has been permanently disposed of by this work.

Very respectfully, your obedient servant,

WM. PIERSON JUDSON,
Assistant Engineer.

Capt. DAN C. KINGMAN,
Corps of Engineers.

COMMERCIAL STATISTICS.

Arrivals and departures of vessels at Oswego Harbor, New York, during fiscal year ending June 30, 1895.

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.			
					On lake.		On river.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	303	117,841	189	19,796	193	53,372	.....	.....
Home, on river	45	900	.....	.....	.....	.....	402	56,280
Foreign, on lake	369	79,794	454	80,967	270	72,983	.....	.....
Total	717	198,535	643	100,763	463	126,355	402	56,280
American owned	465	153,153	201	24,303	129	50,809	402	56,280
Canadian owned	252	45,382	442	76,460	334	75,546	.....	.....

Sum total, 2,225 arrivals; 481,933 registered tonnage.
1893, arrivals, 2,697; tonnage, 543,023. 1894, arrivals, 2,776; tonnage, 544,533.

DEPARTURES.

Home, on lake	339	145,694	207	25,934	91	20,151	.....	.....
Home, on river	45	900	.....	.....	.....	.....	402	56,280
Foreign, on lake	327	51,671	332	73,664	340	100,782	.....	.....
Total	711	198,265	539	99,598	431	120,933	402	56,280

Sum total, 2,083 departures; 475,076 registered tonnage.

Greatest draft of vessel	feet	14.3
Greatest tonnage of vessel	registered tonnage	1,561
Greatest load of vessel	net tons	2,053

Receipts and shipments by lake and river at Oswego, N. Y., during the fiscal year ending June 30, 1895.

Trade.	Receipts.						Shipments.					
	Passengers.	Grain.	Coal.	Merchandise.	Fish.	Lumber, etc.	Passengers.	Grain.	Coal.	Merchandise.	Oil.	Lumber.
		Net tons.	*Net tons.*	*Net tons.*	*Net tons.*	*Tons.*		*Net tons.*	*Net tons.*	*Net tons.*	*Net tons.*	
Home, on lake	1,671	42,866	330	7,993	16	4,101	3,285	.....	212,977	830	25	269
Home, on river	.....	2,500	7,115	6,505	.....	1,123	.....	36,550	4,344	9,099	.....	40,559
Foreign, on lake	73	16,122	.....	918	60	109,707	50	.....	323,694	1,607	159	.....
Total	1,744	61,488	7,445	15,416	76	114,931	3,335	36,550	541,015	11,536	184	40,828

Navigation closed December 26, 1894; navigation opened April 18, 1895. Total revenue collected at port during fiscal year, $77,776.87. The diminution of revenue is caused by removal of duties from lumber, which is the principal import.

For the purpose of reduction to tons weight the following is assumed, viz: Seven barrels oil equal 1 ton; 1,000 feet lumber equal 1½ tons; 20 crates fruit equal 1 ton; 12 railroad ties and poles equal 1 ton; 1 cord wood and posts equals 1½ tons; 4 live animals equal 1 ton.

RIVERS & HARBORS.

OSWEGO.

NEW YORK.

Harbor of

Oswego, New York

and vicinity,

1895.

Surveyed and drawn under the direction of
Capt. Dan C. Kingman, Corps of Engineers, U.S.A.
By Wm. Pierson Judson, Asst. Engr.
Sept. Oct. 1892.

0 500 1000 1500 2000 feet

Scale of one inch to 375 feet.

Details at the location of the
Proposed East Jetty
are from survey of May 1895.

Dan C. Kingman
Capt. Corps of Engrs, U.S.A.

Fort Ontario 1724-1339-1863

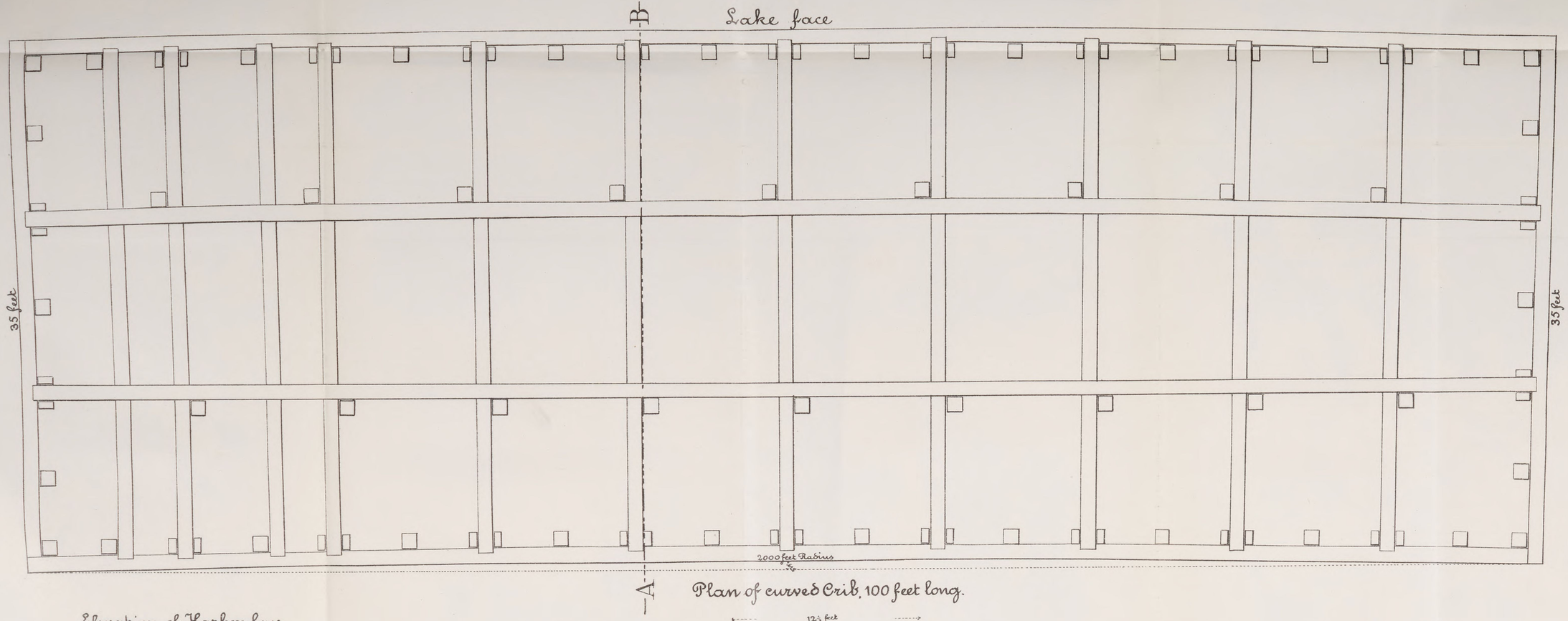
LAKE STREET
BRONSON STREET
VAN BUREN STREET
SCHUYLER STREET
SENECA STREET
CAYUGA STREET
BRIDGE STREET

OSWEGO RIVER
CANAL BASIN

Eng 54 1.

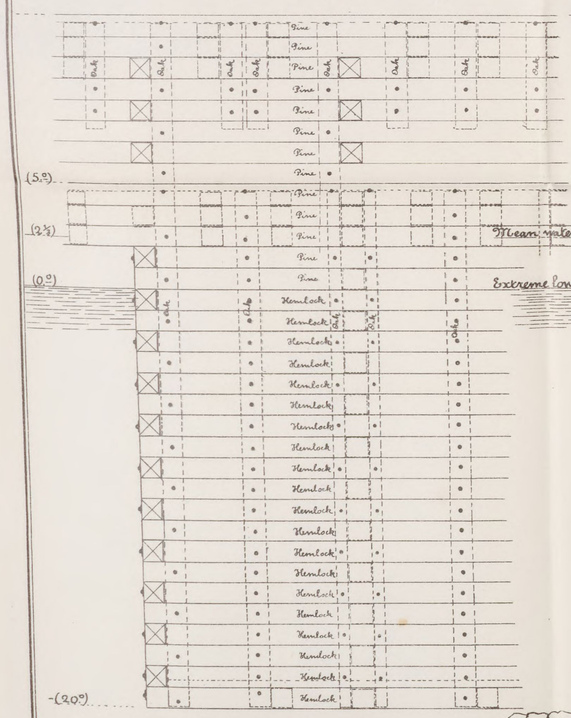
RIVERS & HARBORS. NEW YORK.

OSWEGO.



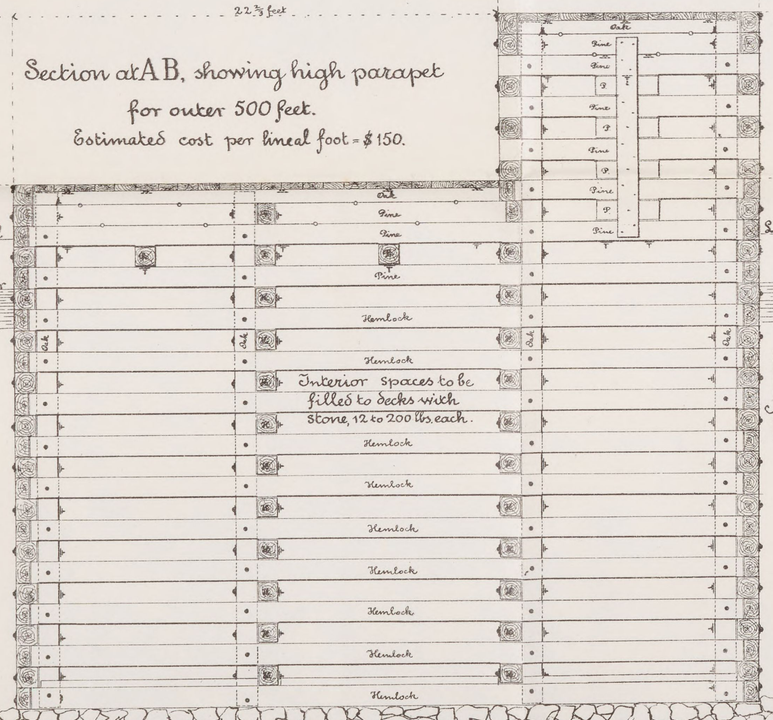
Plan of curved Crib, 100 feet long.

Elevation of Harbor face.



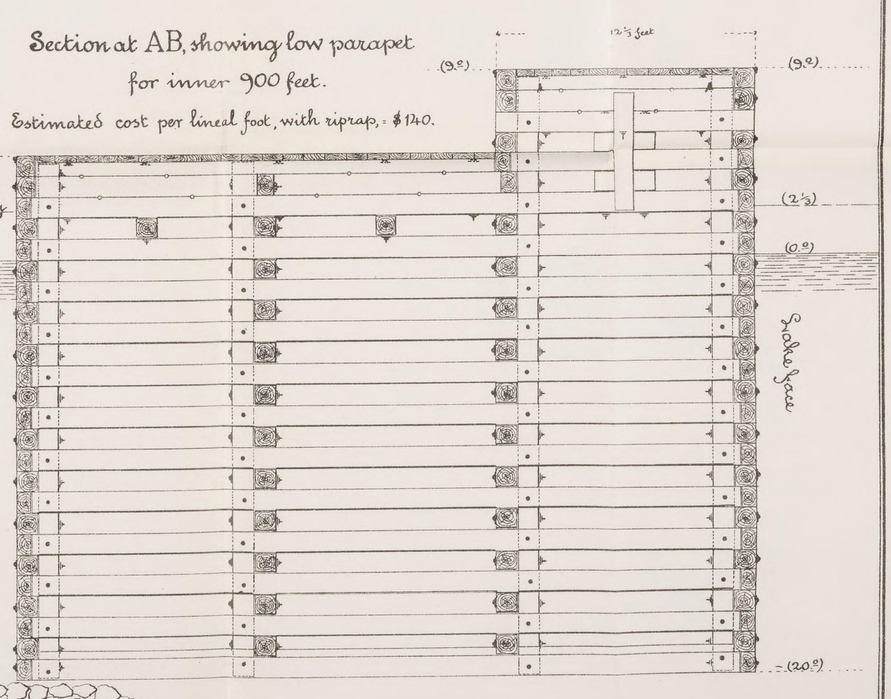
Section at AB, showing high parapet for outer 500 feet.

Estimated cost per lineal foot = $150.



Section at AB, showing low parapet for inner 900 feet.

Estimated cost per lineal foot, with riprap, = $140.



Riprap on naturally hard bottom.

U. S Engineer Office
Oswego, New York, June 8th, 1895.

To accompany map and project and photograph and estimate of this date.

Dan C Kingman
Capt. Corps of Engrs. U.S.A.

Details for Curved East Jetty at the entrance to Oswego Harbor, N.Y.

1895.

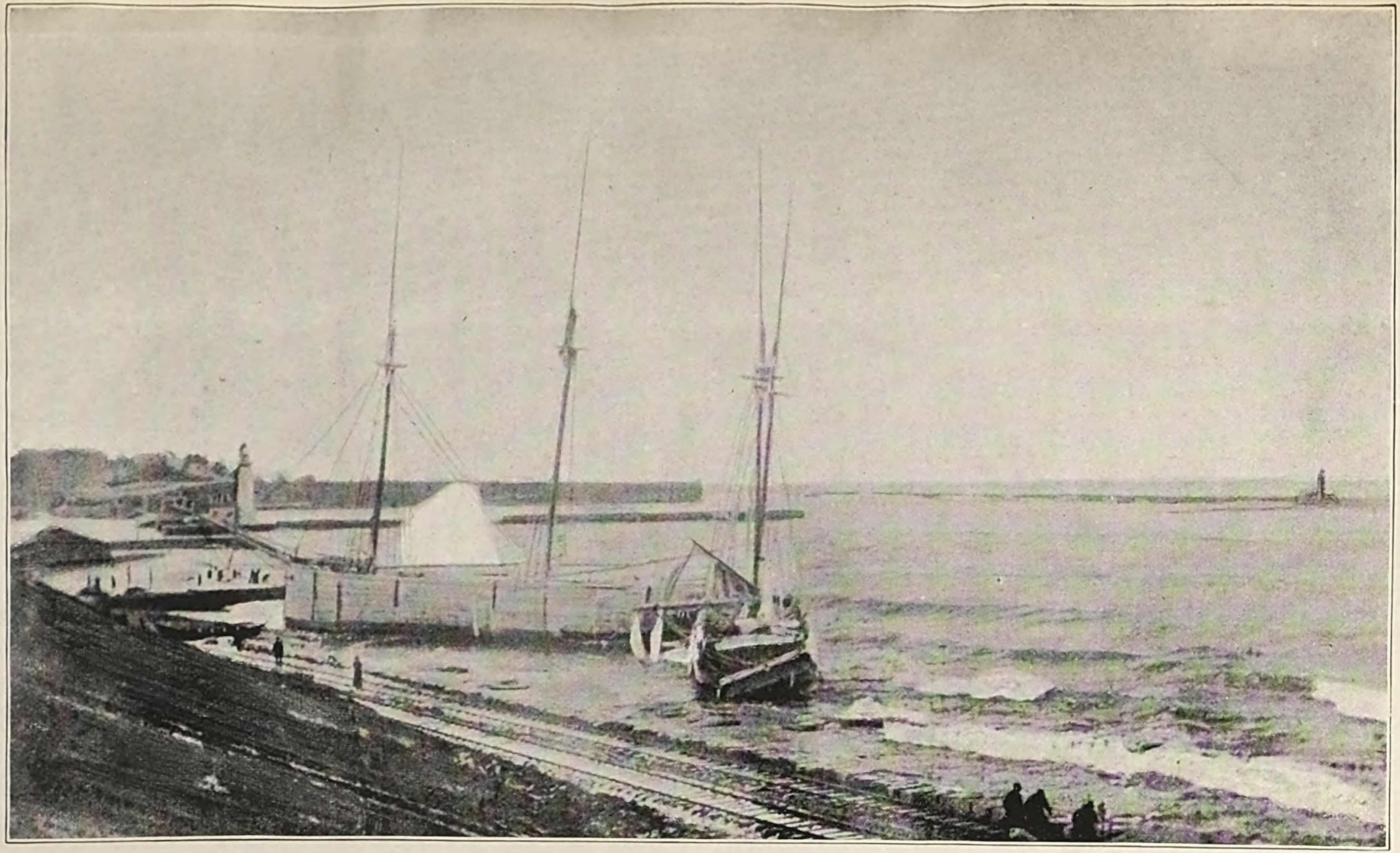
Scale of 1 inch to 6 feet.

Designed under the direction of
Capt. Dan C. Kingman
Corps of Engineers, U.S.A.

By Wm Pierson Judson, Asst. Engr.

May 28th, 1895.

Eng 54 1



PHOTOGRAPH MADE NOVEMBER 27, 1894, SHOWING THE WRECKS OF TWO VESSELS CAST ASHORE AT THE ENTRANCE TO OSWEGO HARBOR, NEW YORK, ON NOVEMBER 25 AND 26, 1894, AND TOTALLY DESTROYED, IN CONSEQUENCE OF THE LACK OF A PROPER EAST BREAKWATER. MANY SIMILAR WRECKS HAVE FORMERLY OCCURRED AT THE SAME PLACE. POINT-OF-VIEW IS MARKED "CAMERA" ON MAP.

O O 6.

IMPROVEMENT OF HARBOR AT SACKETTS HARBOR, NEW YORK.

Object.—To deepen the natural harbor formed by Ship House Point over an area of about 15 acres to 12 feet at extreme low water. This project was adopted in 1881. Previous to this, in 1826–1828, $6,000 had been expended for the same purpose.

Present project.—To limit the excavation to an area of about 6 acres and to define the entrance and provide a mooring place by building a crib 18 feet square upon the point of the shoal extending into the harbor from the end of Ship House Point.

Also to check shore drift by extending a jetty across the end of Ship House Point from the crib above described to the bay outside the point.

The following appropriations have been made for this work:

May 20, 1826	$3,000
May 23, 1828	3,000
August 2, 1882	7,000
August 11, 1888	2,000
August 17, 1894	5,000
Total	20,000

Present works.—A crib 18 feet square has been built as proposed in the project; a jetty of stake and fascine work, loaded with stone, has been completed for a distance of 164 feet, and about 24,000 cubic yards of material have been dredged from the sheltered area, giving a depth of 12 feet at extreme low water.

Operations.—None other than the collection and reporting of commercial statistics.

Remarks.—This harbor is formed by a natural spur of loose rock and gravel, about 800 feet in length, extending in an easterly direction from the shore, so as to form a small sheltered bay, and the value of the harbor depends upon the preservation of this natural spur or breakwater.

During the war of 1812 the United States began the construction of a large naval vessel upon this spur. The vessel was never launched, work on it having been stopped by the treaty of peace; but the vessel was cared for for a great many years, and incidentally the site on which it stood was prevented from any washing away, due to wave action. A few years ago the vessel was sold and broken up, and since then this spur has not been cared for, and consequently is slowly being destroyed by the seas. It is not, however, exposed to very heavy waves, and can be protected by a rough wall of blocks of stone of one or more tons in weight built parallel to it and from 50 to 100 feet in advance of it, where the water is about 6 feet deep. This stone can be advantageously obtained from quarries in the neighborhood, and it is estimated that it can be put in for about $3 a cubic yard. The present appropriation will be applied to this purpose and will be sufficient to complete the proposed wall. No more dredging seems to be necessary at present.

Name of harbor, Sacketts Harbor, N. Y. Collection district, Cape Vincent, N. Y. Nearest light-house, Sacketts Harbor, N. Y.; a fixed white light of the fifth order on Horse Island, 1⅓ miles west of town. Nearest works of defense, Fort Ontario, N. Y.

Money statement.

July 1, 1894, balance unexpended	$317.74
Amount appropriated by act of August 17, 1894	5,000.00
	5,317.74
June 30, 1895, amount expended during fiscal year	38.50
July 1, 1895, balance unexpended	5,279.24

COMMERCIAL STATISTICS.

Arrivals and departures of vessels at Sacketts Harbor, N. Y., during fiscal year ending June 30, 1895

ARRIVALS.

Trade engaged in.	Steamers.		Sailing vessels.		Barges.	
	Number.	Registered tonnage.	Number.	Registered tonnage.	Number.	Registered tonnage.
Home, on lake	5	242	84	2,792	1	281
Foreign, on lake	8	464	4	125	.....	.....
Total	13	706	88	2,917	1	281
American owned	6	317	85	2,823	1	281
Canadian owned	7	389	3	94	.....	.....

Sum total, 102 arrivals; 3,904 registered tonnage.

DEPARTURES.

Home, on lake	7	352	85	2,823	1	281
Foreign, on lake	6	354	3	94	.....	.....
Total	13	706	88	2,917	1	281

Sum total, 102 departures; 3,904 registered tonnage.

Greatest draft	feet..	10
Greatest tonnage	registered tonnage..	281
Greatest load	net tons..	660

Receipts and shipments by lake at Sacketts Harbor, N. Y., during fiscal year ending June 30, 1895.

Trade.	Receipts.						Shipments.	
	Passengers.	Posts and wood.	Merchandise.	Hay.	Coal.	Lumber.	Passengers.	Merchandise.
		Net tons	*Net tons*	*Net tons*	*Net tons*	*Tons.*		*Net tons.*
Home, on lake	20	.....	58	2,047	850	23	20	.....
Foreign, on lake	92	147	.....	.....	.....	3	.....	161
Total	112	147	58	2,047	850	26	20	161

Navigation closed October 26, 1894; navigation opened April 10, 1895.

For the purpose of reduction to tons weight the following is assumed, viz: Barrels oil, 7 equal 1 ton; 1,000 feet lumber equals 1 ton; crates fruit, 20 equal 1 ton; railroad ties and poles, 12 equal 1 ton; cords wood and posts, 1 equals 1½ tons; live animals, 4 equal 1 ton.

OO 7.

PRELIMINARY EXAMINATION OF CHANNEL CONNECTING IRONDEQUOIT BAY WITH LAKE ONTARIO, NEW YORK.

[Printed in House Ex. Doc. No. 300, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 5, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated January 21, 1895, by Capt. Dan C. Kingman, Corps of Engineers, of results of preliminary examination of channel connecting Irondequoit

Bay, New York, with Lake Ontario, made in accordance with the requirements of the river and harbor act of August 17, 1894.

Captain Kingman expresses the opinion that the channel connecting Irondequoit Bay with Lake Ontario is not worthy of improvement by the General Government.

This opinion is concurred in by Col. H. L. Abbot, Corps of Engineers, division engineer, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. DAN C. KINGMAN, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., January 21, 1895.

GENERAL: I have the honor to submit the following report of a preliminary examination of the channel connecting Irondequoit Bay with Lake Ontario, New York:

Irondequoit Bay is on the south side of Lake Ontario, about midway between the mouth of the Niagara River and the head of the St. Lawrence. It is an irregular, rock-bound body of water, extending inland about 4 miles. Its width at its mouth is about 6,000 feet, and it is separated from Lake Ontario by a narrow sand bar, the crest of which is a few feet above the level of high water in the lake, and the width of which above water is from 200 to 600 feet. On the lake side of the bar is a sand beach, and the depth of water increases very gradually, it being a distance of about 1,700 feet from the shore to the 18-foot contour. On the bay side of the bar the water is also shallow for a distance of about 3,500 feet. This portion of the bay is generally overgrown by tall rushes, the growth being intersected by a number of crooked channels and interspersed with patches of open water. The distance, therefore, from deep water in the lake to deep water in the bay is about 1 mile.

After passing beyond shallow water, the bay for a distance of a mile and a quarter is from a quarter to a half mile wide, and for a mile and a half farther there is a width of three-quarters of a mile, throughout which the water is still deep; that is to say, from 30 to 80 feet. The head of the bay is quite shallow, being generally less than 12 feet in depth. The channel connecting the bay with the lake cuts through the sand bar about on the line of the axis of the bay.

At the time that I examined it, in November, 1894, the width of waterway was about 50 feet, and its available depth did not exceed 30 inches; this was from the crest of the bar toward the lake. Toward the bay the channel was somewhat wider, and a depth of 6 feet might perhaps be carried through to the bay. This small channel simply serves to maintain a uniform level between the water in the bay and the water in the lake.

The action of the waves of the lake, and of the wind upon the dry sand of the beach, tends constantly to close up the channel.

At the time that I saw it, it is probable that its size was at a minimum, for at this season of the year there was little to produce a current, and consequently very little scour.

There are a number of brooks and small streams that flow into the bay, and during the spring freshets they no doubt discharge a very considerable volume of water. At this time the current in the channel would be augmented, the scour would increase, and the channel would undoubtedly be enlarged.

I was informed by a man who had lived on the bank of this channel for the past fourteen years that it was scoured out every spring to a width of about 100 feet and a depth of from 12 to 15 feet.

The channel and bay are recognized as navigable waters of the United States. Formerly there was a wharf and warehouse at the upper part of the bay, and certain small vessels visited it from the lake. The channel is now spanned by two low bridges unprovided with drawspans. The bridge nearest the lake is a railroad bridge, forming a part of the Rome, Watertown and Ogdensburg Railroad, and consists of a single span about 110 feet wide, formed by two plate girders, which rest upon abutments of stone. The height of the bridge in the clear above the level of the water at the ordinary stage of the lake is not more than 5 feet, so that this bridge is a total obstruction to the passage of any vessel of sufficient size to engage in useful commerce.

About 50 feet south of this bridge is a wagon bridge with a similar span. It is said to be a town bridge, belonging to the towns of Webster and Irondequoit. It consists of a single-span steel truss. Its length and the clear waterway under it are about the same as in the case of the railroad bridge. This wagon bridge is said to have replaced an older trestle bridge of wood, which bridge was provided with a drawspan. The remains of this old bridge now obstruct the channel. The railroad bridge was erected about twenty years ago.

It is evident that any improvement to the channel would be valueless unless it provided for the removal of these bridges or the substitution for them of bridges with suitable and adequate drawspans.

Owing to the continuous action of the wind and waves to obliterate and destroy this channel it is obvious that any improvement by dredging alone would be very temporary and of little value. The channel on the lake side could only be maintained by first protecting it by jetties of suitable size and construction to resist wave action, and of height and tightness to arrest the motion of the sand.

On the bay side of the bar it is possible that the character of the bottom may be such that a channel dredged through it would be reasonably permanent. If, however, the bottom is very soft and the material of a nature to be easily moved by such waves as can form on the bay, then it would be necessary to protect the cut either by mattress jetties or by some form of sheet piling properly anchored and braced.

There is no question of the possibility of constructing a safe, commodious, and useful harbor at this place, but the need of it is very nearly nullified by the fact that the harbor of Charlotte is situated only 4 miles to the westward of it. I have endeavored to inform myself as to the probable use that would be made of the harbor at Irondequoit Bay, and with this object in view I have communicated with the secretary of the Chamber of Commerce of the city of Rochester. From him I have received a number of communications bearing upon the subject.

It is claimed that the harbor at Charlotte is not a safe winter harbor; that the spring freshets bring down ice in large fields and in such quantities as to leave no safe or sheltered place for a vessel to lie in the harbor. This is undoubtedly true and is a serious detriment to the harbor at Charlotte.

It does not, however, impair its commercial value during the summer months. It is also urged that Irondequoit Bay would be nearer to the city of Rochester and more accessible; that Irondequoit Bay can be very easily connected with the Erie Canal; that its high banks and deep water offer special facilities for the construction of coal trestles, and its nearness to Pennsylvania coal fields would certainly make it an important shipping port; that the city limits of Rochester will shortly be extended to the shores of this bay, and that by opening up this bay to commerce the growth of the city will be greatly augmented.

It is proper to say that the improvement of harbors is designed—and has for its object solely—to benefit the commerce of the United States, and not to promote the growth and improvement of cities, though doubtless it usually has this effect also. But if this were made the principal object of the improvement, it would deprive the work of its national character and importance.

The commerce of Charlotte now amounts to an annual arrival of about 1,200 vessels, having a registered tonnage of something over 300,000 tons. It shipped last year about 330,000 tons of coal, of which a little over one-half went to foreign ports. It can not be said that the harbor at Irondequoit Bay is demanded because the resources of the harbor at Charlotte are overtaxed, but I think that a harbor at Irondequoit Bay might, perhaps, be a better and safer one than that at Charlotte. I think its cost of maintenance would be about the same.

The total amount expended at Charlotte from 1828 to the present time is about $500,000. Its average annual cost of maintenance can not be assumed to be much less than $8,000 or $10,000. That at Irondequoit Bay would be about the same.

It would hardly seem wise or necessary to maintain both of these harbors, and the question is whether the harbor at Charlotte should be abandoned and the other improved in the manner indicated.

As already stated, I think the harbor at Irondequoit might prove to be the better and safer one, but in view of the large amount of money that has been expended at Charlotte I can not recommend that it be abandoned. I am therefore of the opinion that the channel connecting Irondequoit Bay with Lake Ontario is not worthy of improvement.

The following communications bearing upon the subject of the improvement of the channel connecting Irondequoit Bay with Lake Ontario have been received by me and are respectfully submitted herewith:

*A. A letter of Mr. George Moss, secretary of the Rochester Chamber of Commerce, transmitting the following, namely:

*B. A letter of Mr. Horace W. Sibley, giving reasons why the opening of Irondequoit Bay would be of great value to the city of Rochester and showing why the harbor at Charlotte is unsafe in winter.

*Also, Exhibit C, a letter (printed) of Mr. J. Y. McClintock, city engineer of Rochester, N. Y., showing the great advantages to commerce that would result from the improvement of the channel, also stating that Irondequoit Bay would afford a most convenient point at which to connect the Erie Canal with Lake Ontario.

*Exhibit D is a second letter from Mr. Moss, transmitting the following:

*E. A letter signed by C. E. Morris and N. L. Button, giving some of the early history of this bay and stating that it was formerly an important and valuable harbor and accessible to the largest class of

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* Not printed.

vessels then found upon the lake, and that its improvement would make it an ideal harbor, and—

* F. A letter from Hon. Charles S. Baker, ex-Member of Congress, stating that there can be no question as to the desirability of the proposed improvement from every economic standpoint, while from a purely military point of view every consideration recommends the project, and—

* Exhibit G, a letter from John Bower stating that vessels formerly entered this bay without difficulty and pointing out its future value in case of war if the entrance is properly improved.

* Exhibit H, some notes (unsigned) submitted by Mr. Moss pointing out the advantages that would result from the proposed improvement.

* Exhibit I, a map of Rochester and vicinity submitted by Mr. Moss.

* Exhibit K is a map compiled in this office to show more correctly the present condition of the channel and bay.

This same matter was reported upon by Capt. Carl F. Palfrey, Corps of Engineers, under date of February 12, 1889. His report is exceedingly concise and leaves but little to be said upon the subject. I have availed myself of it fully in the preparation of the foregoing.

I have the honor to be, very respectfully, your obedient servant,

DAN C. KINGMAN,
Captain of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. H. L. Abbot, Corps of Engineers, Division Engineer, Northeast Division.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, January 26, 1895.

Respectfully forwarded to the Chief of Engineers, United States Army.

For the reasons stated herein, and for the further reasons that our commerce between Lake Ontario and Lake Erie is handicapped by the want of water communication under American control, and that we have already four good harbors on Lake Ontario—Oswego, Great Sodus, Little Sodus, and Charlotte—I concur with Captain Kingman and Captain Palfrey in considering Irondequoit Bay as unworthy of improvement at the expense of the General Government.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

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* Not printed.

APPENDIX P P.

IMPROVEMENT OF RIVERS AND HARBORS IN VERMONT AND NORTHERN NEW YORK.

REPORT OF CAPT. SMITH S. LEACH, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Shoals between Sister Islands and Cross-over Light, St. Lawrence River, New York.
2. Ogdensburg Harbor, New York.
3. Breakwater at Rouse Point, Lake Champlain, New York.
4. Great Chazy River, New York.
5. Plattsburg Harbor, New York.
6. Burlington Harbor, Vermont.
7. Otter Creek, Vermont.
8. Ticonderoga River, New York.
9. Narrows of Lake Champlain, New York and Vermont.

EXAMINATIONS.

10. Waddington Harbor, New York.
11. Missisquoi River, Vermont.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., July 1, 1895.

GENERAL: I have the honor to transmit herewith annual reports for the river and harbor works under my charge during the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

SMITH S. LEACH,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

P P 1.

IMPROVEMENT OF SHOALS BETWEEN SISTER ISLANDS AND CROSS-OVER LIGHT, ST. LAWRENCE RIVER, NEW YORK.

The project for this improvement resulted from a survey and report made in compliance with a provision in the river and harbor act of August 11, 1888, directing a survey of the shoals between Sister Islands and Cross-over Light to be made. The report was submitted July 2, 1889, and printed in the Report of the Chief of Engineers, 1889, pages 2463 and 2464.

The estimate, as below, provided for the removal to a depth of 18 feet at low water of three shoals, the first or lower one situated a little above the entrance to Blind Bay; the second or middle one, near Dark Island; the third or upper one, about 1½ miles above Dark Island, the distance between the lower and upper shoal being about 4 miles.

ESTIMATE.

Removing 162 cubic yards of rock, lower shoal, at $20 per cubic yard	$3,240
Removing 1,830 cubic yards of rock, middle shoal, at $18 per cubic yard	32,940
Removing 85 cubic yards of rock, upper shoal, at $25 per cubic yard	2,125
Contingencies	5,000
Aggregate	43,305

The discovery of three outlying spurs of the upper or "Haskell" Shoal, the removal of which was necessary to free the locality from dangerous obstructions, called for a revised estimate, which was submitted in the last annual report, as follows:

REVISED ESTIMATE, 1893.

Removing 2,627 cubic yards of rock, at $20.85	$54,772

Appropriations of $5,000 in the act of September 19, 1890, and $10,000 in the act of July 13, 1892, have been expended under contract and have resulted in the removal of the upper and lower shoals, leaving the middle or Dark Island Shoal, estimated to require $32,940, yet to be removed.

The sum of $8,000, appropriated for this work in the act approved August 17, 1894, added to the balance of $2,796.74 then on hand, made $10,796.74 available for work on the date named. This being insufficient for the completion of the pending project by the removal of the Dark Island Shoal, estimated to cost $32,940, and it being obvious that the removal of a part of it would be of no benefit to navigation, it was decided to apply the funds, so far as needed, to the removal of a number of small and dangerous shoals discovered since the project was made and not included therein. They are described in the following table:

No.	Latitude.	Longitude.	Depth.	Yardage.
	° ′ ″	° ′ ″	*Feet.*	
1	44 30 17	75 46 27	13	250
9	44 28 33	75 47 16	14	165
10	44 28 41	75 47 10	16	25
X	44 28 45	75 47 10	15	135

After due advertisement bids were opened January 17, 1895, and a contract was entered into with Lynch & Hannan, of Ogdensburg, N. Y., the lowest bidders, for the removal of 600 yards, more or less, from these shoals, at $8.49 per yard. Work on this contract is to be finished by November 30, 1895. The contractors are now building a drill boat for the work, but have not yet fixed a time for beginning.

APPROPRIATIONS.

Act of—	
September 19, 1890	$5,000
July 13, 1892	10,000
August 17, 1894	8,000
Total	23,000

Money statement.

July 1, 1894, balance unexpended	$3,186.50
Amount appropriated by act of August 17, 1894	8,000.00
	11,186.50
June 30, 1895, amount expended during fiscal year	867.94
July 1, 1895, balance unexpended	10,318.56
July 1, 1895, amount covered by uncompleted contracts	6,810.00
July 1, 1895, balance available	3,508.56
Amount (estimated) required for completion of existing project	29,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	29,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for removal of shoals near Cross-over Light, St. Lawrence River, New York, received in response to advertisement dated December 17, 1894, and opened January 17, 1895, by Capt. Smith S. Leach, Corps of Engineers.

[Approximate quantity of rock to be removed, 600 cubic yards.]

No.	Name and address of bidder.	Price bid per yard measured in place.	Amount.
1	Willard Johnson, Fulton, N. Y.	$10.25	$6,150.00
2	William James Daly, Ogdensburg, N. Y.	9.00	5,400.00
3	Lynch & Hannan, Ogdensburg, N. Y.	8.49	* 5,094.00
4	Hingston & Woods, Buffalo, N. Y.	9.45	5,670.00

* Lowest bid. Accepted and contract entered into.

Amount available for payment of contractor's estimates for above work, $9,500.

COMMERCIAL STATISTICS.

Nearly the entire commerce of the St. Lawrence River passes over or near these shoals. The nearest light-house, Cross-over Light; greatest draft of vessels, 16 feet.

Amount of commerce which passed over the shoals of the St. Lawrence River between Sister Islands and Cross-over Light during the calendar year 1894.

	Tons.
Entered and cleared at Ogdensburg from and to points west (see reports for Ogdensburg Harbor)	773,708
Passed through Cardinal canals and down Galops Rapids (from data courteously furnished by John H. Balderson, secretary department of railways and canals, Ottawa)	550,757
Total tonnage passing the section of river under improvement in 1894.	1,324,465

P P 2.

IMPROVEMENT OF OGDENSBURG HARBOR, NEW YORK.

The object of this improvement has been the formation of a channel along the wharf frontage of the port of Ogdensburg of adequate width and depth, with entrances connecting this channel with deep water in the St. Lawrence River. The work has been carried on under three successive projects, adopted in 1868, 1882,. and 1890. These projects

have covered substantially the same areas, but have provided for a progressive deepening from the original depths of 5 to 12 feet to proposed depths of 12, 15, and 16½ feet, respectively.

The project of 1890 was adopted while that of 1882 was still incomplete, and was estimated to cost $158,950. The act of 1890 appropriated $42,000, which was expended under contract in part execution of the project. After extension, at contractor's cost, work was completed on June 8, 1893, giving a channel of the proposed depth and 150 feet in width from the lower end of the harbor nearly to the lower side of the Oswegatchie River, with two entrances from the St. Lawrence.

The appropriation in the act of 1892, $40,000, has been expended under contract, and has resulted in the extension of the 150-foot channel to and across the mouth of the Oswegatchie River, with narrow cuts extending along the sides of that stream, to reach the coal wharves and the grain elevator, to both of which full cargoes can now be carried.

Under the appropriation of $20,000 in act of August 17, 1894, bids were opened October 5, 1894, and a contract entered into with William James Daly, of Ogdensburg, N. Y., the lowest bidder, for dredging 5,000 cubic yards, more or less, of hardpan, at 35 cents, and 160,000 cubic yards, more or less, of mud, at 10 cents per yard. The contractor began work October 17, 1894, laid up for the winter on November 28, 1894, resumed on May 7, 1895, and at the close of the fiscal year had removed 9,745 cubic yards of hardpan and 51,650 yards of mud, leaving 91,742 yards of mud to be removed. The contract expires November 30, 1895, and will doubtless be completed by that date.

While work was in progress in the fall of 1894, the spare time of the inspector was utilized in a resurvey of the project area. The upper entrance, along the railroad pier, was found to be partially closed by drifting sands, and some shoaling was found near the outlet of a sewer and of a large surface drain. The latter shoals have not as yet become an obstruction to navigation and do not require immediate attention. The upper entrance, however, seemed to require attention under this appropriation. Both by the character of material to be dredged and the exposure of the situation, the work could not fairly be required under the pending contract. The contractor offered to waive the difference of materials, and to offset the increased exposure a recommendation was made for the payment, under supplementary articles of agreement, of the running cost of the dredge for time actually lost by reason of the exposed situation. This recommendation was not approved, and as the present appropriation is fully pledged under the pending contract, the deepening of this entrance must be deferred.

Further appropriations will be expended in widening the dredged channel and restoring the project depth.

APPROPRIATIONS.

Act of—	
August 30, 1852	$3,000.00
March 2, 1867	40,000.00
July 11, 1870	15,000.00
March 3, 1871	25,000.00
June 10, 1872	10,000.00
March 3, 1873	6,000.00
June 23, 1874	6,000.00
March 3, 1875	5,000.00
December 11, 1877 (allotment from appropriation for "repairs of harbors on Northern Lakes")	5.56
September 10, 1879 (allotment from appropriation for "examinations, surveys, and contingencies of rivers and harbors")	300.00
July 28, 1880 (allotment from appropriation for "examinations, surveys, and contingencies of river and harbors")	50.00

Act of—	
August 2, 1882	$10,000.00
July 5, 1884	15,000.00
August 5, 1886	10,000.00
August 11, 1888	15,000.00
September 19, 1890	42,000.00
July 13, 1892	40,000.00
August 17, 1894	20,000.00
Total	262,355.56

Money statement.

July 1, 1894, balance unexpended		$947.10
Amount appropriated by act of August 17, 1894		20,000.00
		20,947.10
June 30, 1895, amount expended during fiscal year		7,636.85
July 1, 1895, balance unexpended		13,310.25
July 1, 1895, outstanding liabilities	$3,391.19	
July 1, 1895, amount covered by uncompleted contracts	9,919.06	
		13,310.25
Amount (estimated) required for completion of existing project		56,950.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		56,950.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of proposals received in response to advertisement dated September 5, 1894, and opened October 5, 1894, by Capt. Smith S. Leach, Corps of Engineers, for dredging in Ogdensburg Harbor, New York.

No.	Name and address of bidder.	5,000 cubic yards hardpan.		160,000 cubic yards mud.		Total.
		Per yard.	Amount.	Per yard.	Amount.	
		Cents.		*Cents.*		
1	Carkin, Stickney & Cram, Saginaw, Mich...	37	$1,850	11	$17,600	$19,450
2	William James Daly, Ogdensburg, N. Y.....	35	1,750	10	16,000	*17,750
3	Lynch & Hannan, Ogdensburg, N. Y.....	40	2,000	11	17,600	19,600

* Lowest bid. Accepted and contract entered into.

Amount available for payment of contractor's estimates, $17,750.

COMMERCIAL STATISTICS.

Name of harbor, Ogdensburg, N. Y.; collection district, Oswegatchie; nearest light-house, Ogdensburg, N. Y.

Tonnage of vessels entered and cleared, foreign ports and coastwise, 1894.

	East of Ogdensburg.				West of Ogdensburg.			
	American vessels.		Foreign vessels.		American vessels.		Foreign vessels.	
	Entered.	Cleared.	Entered.	Cleared.	Entered.	Cleared.	Entered.	Cleared.
	Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
Foreign ports	25,551	5,907	56,786	27,963	16,372	5,820	17,221	14,361
Coastwise	2,580	2,622	.....	.....	337,829	382,105	.....	.....

Merchandise received and shipped, foreign ports.

Articles.	Tons.
Received:	
Lumber	64,301
Barley, wheat, and other grain	4,349
Hay	3,609
Miscellaneous freight	1,998
Shipped:	
Coal	75,228
Wheat, rye, oats, and corn	11,905
Cheese	3,384
Oil	3,722
Miscellaneous freight	17,952

Merchandise received and shipped, coastwise.

Articles.	Tons.
Received:	
Lumber	50,730
Grain	174,587
Flour	24,405
Coal	109,219
Miscellaneous freight, east bound	81,000
Bran and feed	58,695
Shipped:	
Miscellaneous freight, west bound	51,000

Total dues collected	$83,560.36
Total fees collected	2,268.15
Value of imports	3,489,297.00
Value of exports	3,087,033.00
Value of merchandise entered for warehouse and transshipped in bond	54,205.00
Value of merchandise entered for transshipment and export	236,516.00
Amount of duties on the above	69,439.39

Merchandise received under consular seal from foreign ports, 1894.

Articles.	Packages.	Value.
Tea	110,444	$864,195
Curios	2,249	86,122
Raw silk	2,868	1,145,909
Silk goods	1,570	830,607
Straw braid	1,789	63,194
Chinese groceries	2,554	9,998
Copper matte.....pounds	13,587,458	575,342
Skins	41	8,477
Rice	1,958	7,965
Miscellaneous	8,204	323,125
Total	.....	3,914,934
Estimated duties on the above	.....	517,200

P P 3.

BREAKWATER AT ROUSE POINT, LAKE CHAMPLAIN, NEW YORK.

The project for this improvement was adopted in 1885, and contemplated the construction of a straight breakwater extending from Stony Point in a southeasterly direction to the 18-foot curve in the lake, a distance of about 2,000 feet, at an estimated cost of $110,000, or $55 a linear foot. The all-stone type of structure was adopted, consisting of a rubble foundation and a superstructure or parapet of rubble, faced with large stones, laid with moderately close joints and in fairly true lines and surfaces.

Under the appropriations of 1884, 1886, 1888, and 1890, aggregating $83,500, contracts were made and executed resulting in the completion of 1,700 feet of the breakwater. It was then found that the 18-foot curve was 125 feet from the unfinished end, and it was decided to close the work with an extension of 135 feet. The act of 1892 appropriated $15,000 for making such extension, which was placed under contract.

Work was begun in the fall of 1892, resumed on the opening of navigation in 1893, and completed in October, 1893. The breakwater is now completed, at a cost per foot slightly less than the estimate, and at a total cost, owing to reduced length, of $98,467.55, against $110,000 estimated.

APPROPRIATIONS.

Act of—	
July 5, 1884	$35,000
August 5, 1886	20,000
August 11, 1888	13,500
September 19, 1890	15,000
July 13, 1892	15,000
Total	98,500

Money statement.

July 1, 1894, balance unexpended	$65.71
June 30, 1895, amount expended during fiscal year	33.26
July 1, 1895, balance unexpended	32.45

COMMERCIAL STATISTICS.

Name of harbor, Rouse Point, N. Y.; collection district, Champlain; nearest light-house, Windmill Point.

Vessels entered and cleared, 1894.

	Number.	Tonnage.
Entered	980	94,528
Cleared	86	7,903

Duties collected	$201,912.81
Duties assessed on merchandise entered for warehouse and transportation to other ports.	113,591.69
Tonnage tax collected	2,646.06
Fees collected	5,515.90
Total assessed and collected	323,666.46

Number of tons shipped and arrived, Rouse Point, N. Y., 1894.

Articles.	Shipped.	Arrived.
	Tons.	*Tons.*
Boards, deals, plank, etc	516	159 360
Other lumber	.....	129,000
Coal	84,713	4,000
Miscellaneous articles	10,326	7,476

P P 4.

IMPROVEMENT OF GREAT CHAZY RIVER, NEW YORK.

The project for this improvement, adopted in 1889, was based on a survey made in accordance with the river and harbor act of 1888. It was proposed to dredge a channel 40 feet wide and 5 feet deep at low water from the 5-foot curve in the lake to Champlain Village, a distance of 5½ miles, at an estimated cost of $18,000.

An appropriation of $10,000 in the act of 1890 was expended by contract in part execution of this project, and to secure the greatest benefit from the work done it was determined to make a single cut over the entire length. This was nearly accomplished. The dredging, beginning at the lake, had reached the lower part of the village, when the funds were exhausted, giving for the length worked over a channel something more than half the proposed width and of the full depth.

The appropriation of $5,000 in the act of 1892 was expended under contract in widening the channel at some points and in extending the single cut to within 500 feet of the bridge, which limits the project.

Under the appropriation of $3,000 in act of August 17, 1894, to complete the project, a contract has been made with Lynch & Hannan, of Ogdensburg, N. Y., the lowest bidders, for dredging 5,500 cubic yards, more or less, at 45 cents a yard. This quantity of work will be so distributed as to procure, substantially, the width, depth, and length of channel above described and thus complete the project.

This contract should have been completed by June 30, 1895, but at that date work had not begun. It requires but a few days' work when once started, and will doubtless be completed within a few weeks. The delay will be at contractors' cost.

APPROPRIATIONS.

Act of—	
September 19, 1890	$10,000
July 13, 1892	5,000
August 17, 1894	3,000
Total	18,000

Money statement.

July 1, 1894, balance unexpended	$339.35
Amount appropriated by act of August 17, 1894	3,000.00
	3,339.35
June 30, 1895, amount expended during fiscal year	55.20
July 1, 1895, balance unexpended	3,284.15
July 1, 1895, amount covered by uncompleted contracts	3,284.15

Abstract of proposals for dredging in Great Chazy River, New York, received in response to advertisement dated September 5, 1894, and opened October 5, 1894, by Capt. Smith S. Leach, Corps of Engineers.

[Approximate quantity of material to be dredged, 5,500 cubic yards.]

No.	Name and address of bidder.	Price bid per yard.	Amount.
		Cents.	
1	William James Daly, Ogdensburg, N. Y.	60	$3,300
2	Lynch & Hannan, Ogdensburg, N. Y.	45	* 2,475

* Lowest bid. Accepted and contract entered into.

Amount available for payment of contractors' estimates for above work, $2,500.

COMMERCIAL STATISTICS.

Name, Great Chazy River, New York; collection district, Champlain; nearest light-house, Isle La Motte.

Vessels arrived and departed, 1894.

Character of craft.	Arrived.		Departed.	
	Number.	Tons.	Number.	Tons.
Steam vessels	56	478	56	478
Canal boats	53	4,416	53	4,416

Cargoes:
Value of arrivals $78,436
Value of departures 2,875

Number of tons arrived and shipped, 1894.

Articles.	Shipped.	Arrived.
	Tons.	*Tons.*
Potatoes	260	.....
Hay	75	.....
Iron	.....	150
Coal	.....	1,560
General merchandise	425	518

P P 5.

IMPROVEMENT OF PLATTSBURG HARBOR, NEW YORK.

The original project for the improvement of this harbor was adopted probably in 1836, the date of the first appropriation, and proposed the construction of a breakwater about 1,000 feet east of the steamboat docks.

There were 1,250 linear feet of breakwater constructed between the years 1836 and 1875.

The modification of 1870 provided for an extension of the former structure southeastward, the dredging of some shoal areas within the breakwater, and the protection of a portion of the adjacent beach by a revetment.

Operations were confined to necessary repairs and the dredging of limited areas near the steamboat docks after the completion of the project of 1870 until the act of September 19, 1890, made provision for a northward extension to the breakwater 300 feet, and for replacing by a stone parapet the crib superstructure of the older part.

Under the appropriation of $32,500 in the act of 1890 this final project was completed, operations having been closed, as stated in the last Annual Report, on January 17, 1893:

APPROPRIATIONS.

Act of—		Act of—	
July 4, 1836	$10,000.00	March 3, 1873	$10,000.00
March 3, 1837	10,000.00	June 23, 1874	5,000.00
July 7, 1838	27,500.00	March 3, 1879	2,000.00
March 3, 1843	2,680.01	June 14, 1880	1,000.00
June 11, 1844	10,000.00	August 5, 1886	5,000.00
May 19, 1864 (allotment)	2,000.00	August 11, 1888	7,000.00
March 2, 1867	26,000.00	September 19, 1890	32,500.00
July 11, 1870	10,000.00		
March 3, 1871	15,000.00	Total	185,680.01
June 10, 1872	10,000.00		

Money statement.

July 1, 1894, balance unexpended	$267.97
June 30, 1895, amount expended during fiscal year	28.72
July 1, 1895, balance unexpended	239.25

COMMERCIAL STATISTICS.

Name of harbor, Plattsburg, N. Y.; collection district, Champlain; nearest lighthouse, Cumberland Head; two beacon lights on the Plattsburg breakwater.

Arrivals and departures of vessels, 1894.

Character of craft.	Arrivals.		Departures.	
	Number.	Tonnage.	Number.	Tonnage.
Steam vessels	924	541,005	924	541,005
Sail vessels	54	4,487	54	4,487
Canal boats	57	4,836	57	4,836
Total	1,035	550,328	1,035	550,328

Value of goods shipped	$264,315
Value of goods arrived	106,432

Number of tons arrived and shipped, Plattsburg Harbor, New York, 1894.

Articles.	Shipped.	Arrived.
	Tons.	*Tons.*
Iron ore	2,275	.....
Potatoes	3,414	.....
Coal	.....	18,836
Lumber	6,387	5,427
Iron	1,450	8,355
General merchandise	6,500	5,342
Total	20,026	37,960

Vessels enrolled at Plattsburg Harbor, New York, December 31, 1894.

Number	344
Gross tonnage	34,843.80
Net tonnage	32,649.37

PP 6.

IMPROVEMENT OF BURLINGTON HARBOR, VERMONT.

The first project for the improvement of this harbor was probably adopted in 1836. Modifications of the original project have been made from time to time so as to afford adequate protection to the increasing commercial and shipping interests of the harbor.

In 1874 an extension of 2,000 linear feet northward was proposed and carried out; in 1884 the officer then in charge proposed an extension to the southward; and again, in 1886, a plan for further extension at both ends of the breakwater was considered by the Board of Engineers and

received its authoritative sanction in regard to distance from shore. A 200-foot opening recommended at the north end of the existing structure in prolonging the breakwater in that direction also received approval.

It is now proposed to gradually withdraw the ends of the breakwater, in prolonging it, from water 36 and 39 feet into water about 30 feet deep, and then to keep at a distance of about 1,000 feet from the docks in constructing new work, so as to reduce the cost.

The construction of 360 feet northward extension of the breakwater, with stone superstructure, fully described in the Annual Report for 1892 for this district, was the last new work at this harbor.

The older parts of the timber superstructure are now much decayed, and in view of the success which has attended the application of stone parapets on subaqueous cribs it does not seem profitable to attempt any repairs except by replacement of the timber by stone. The systematic renewal of the superstructure on this plan has begun under the appropriation of $10,000 in act of August 17, 1894, which, together with the balance of over $15,000 remaining on hand, has been pledged under a contract made with Luther Whitney, Keeseville, N. Y., the lowest bidder, for the renewal of about 990 feet of the oldest and worst decayed parapet. This contract extends to June 30, 1896, and work on it has already begun.

Subsequent appropriations will be applied in continuation of this work of removal, until an indestructible structure is secured.

APPROPRIATIONS.

Act of—		Act of—	
July 4, 1836	$10,000.00	March 3, 1875	$25,000.00
March 3, 1837	10,000.00	August 14, 1876	20,000.00
July 7, 1838	50,000.00	June 18, 1878	20,000.00
June 11, 1844	10,000.00	March 3, 1879	15,000.00
August 30, 1852	10,000.00	June 14, 1880	10,000.00
May 19, 1864	308.00	March 3, 1881	10,000.00
June 23, 1866	27,672.20	August 2, 1882	12,000.00
March 2, 1867	80,000.00	July 5, 1884	50,000.00
July 11, 1870	25,000.00	August 5, 1886	18,750.00
March 3, 1871	30,000.00	August 11, 1888	35,000.00
June 10, 1872	30,000.00	September 19, 1890	20,000.00
March 3, 1873	25,000.00	August 17, 1894	10,000.00
June 23, 1874	25,000.00	Total	578,730.20

Money statement.

July 1, 1894, balance unexpended	$15,565.65
Amount appropriated by act of August 17, 1894	10,000.00
	25,565.65
June 30, 1895, amount expended during fiscal year	452.99
July 1, 1895, balance unexpended	25,112.66
July 1, 1895, amount covered by uncompleted contracts	25,112.66
Amount (estimated) required for completion of existing project	119,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Abstract of proposals received in response to advertisement dated September 5, 1894, and opened October 5, 1894, by Capt. Smith S. Leach, Corps of Engineers, for repairs to Burlington Breakwater, Vermont.

No.	Name and address of bidder.	Facing and apron stone (8,910 tons of 2,000 pounds).		Drift and ring bolts (3,300 pounds).		Removing timber and rehandling rubble of old work (990 running feet).		Total.
		Per ton.	Amount.	Per pound.	Amount.	Per foot.	Amount.	
1	Luther Whitney, Keeseville, N. Y.	$2.13	$18,978.30	$0.06	$198.00	$2.80	$2,772.00	*$21,948.30
2	Willard Johnson, Fulton, N. Y ...	3.00	26,730.00	†.10 ‡.06	165.00 115.50	4.50	4,455.00	31,465.50
3	Fleury & Goodsell, Isle La Motte, Vt	2.70	24,057.00	.10	330.00	4.50	4,455.00	28,842.00

* Lowest bid; accepted and contract entered into. † Ring bolts. ‡ Driftbolts.

Amount available for payment of contractor's estimates, $22,000.

COMMERCIAL STATISTICS.

Name of harbor, Burlington, Vt.; nearest light-house, Juniper Island; collection district, Vermont; two beacon lights on the Burlington Breakwater.

Arrivals and departures of vessels, 1894.

	Arrivals.		Departures.	
	Number.	Tons.	Number.	Tons.
From and to lake ports	1,780	569,689	1,786	569,756
From and to Canadian ports	110	13,771	102	13,025
Total	1,890	583,460	1,888	582,781

Merchandise received and shipped, 1894.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
RECEIVED.			RECEIVED—continued.		
Lumber ....feet..	18,408,531	$180,844.00	Coal ....tons..	43,017	$193,576.50
Pickets ....pieces..	723,162	5,948.00	General merchandise, tons	22,950	1,110,000.00
Match blocks....cords..	170	850.00			
Shingles ....pieces	1,360,000	1,735.00			
Railroad ties	4,000	1,200.00	Total (estimated quantity, 91,094 tons)		1,553,426.50
Iron pipe....tons..	1,250	29,375.00			
Stone ....do....	10,172	9,000.00			
Gravel....do....	660	342.00			
Hay ....do....	700	8,400.00	SHIPPED.		
Sand....do....	878	250.00	Lumber....tons..	1,928	25,750.00
Limestone ....do....	570	2,500.00	Coal ....do....	300	1,500.00
Cedar posts....pieces..	1,900	228.00	Gravel....do....	75	40.00
Brick and tile....do....	100,500	603.00	General merchandise, tons	10,600	560,000.00
Beans ....bushels..	900	1,800.00			
Oats ....do....	2,000	700.00			
Apples....barrels..	1,000	2,500.00	Total ....tons..	12,903	587,290.00
Firewood ....cords..	275	825.00			
Timber (hard pine) feet..	110,000	2,750.00			

The above commercial statistics were supplied by the collector of customs in response to the usual request for them.

P P 7.

IMPROVEMENT OF OTTER CREEK, VERMONT.

The object of this improvement is to afford a channel of navigable width and a depth of 8 feet at low water from the town of Vergennes, Vt., to Lake Champlain. The original project was adopted in 1872, and was estimated to cost $58,146. In 1882 surveys developed the fact that rock in situ would be encountered within the proposed limits of width and depth and the estimate was increased to $73,748.40. In 1884 a relocation of the channel at Bull Brook Bend avoided part of the rock excavation, reducing the cost by about $500, and the lower prices which have prevailed in recent years have insured the completion of the project for less than the revised estimate of 1882.

Occasional expenditures for maintenance will doubtless be required. It has been found necessary to repeat operations at Bull Brook Bend, and it is quite probable that accretions will again occur on the shoals there and elsewhere during the season of freshets. Such cost of maintenance will not, it is believed, be excessive in relation to the first cost of the improvement, and they will be very small as compared with the traffic benefited.

The last work on this stream was done in 1893–94 and resulted in opening the projected channel to the public landing and within 500 feet of its upper terminus. Above this point the channel was dredged to rock in 1891. To complete the project this length must be excavated to the project depth. The volume to be taken out is 3,700 cubic yards, and a bowlder at Bull Brook Bend should be removed and a cut made at the mouth of the creek to ease an abrupt turn.

The appropriation of $5,000 in act of August 17, 1894, together with the balance of $1,551.37 remaining on hand, has been pledged under contract with Lynch & Hannan, of Ogdensburg, N. Y., the lowest bidders, for the removal of 1,160 cubic yards of rock at $5 per yard. The contract expires September 1, 1895. Its execution will extend the channel about 250 feet upstream.

APPROPRIATIONS.

Act of—		Act of—	
June 10, 1872	$10,000	August 11, 1888	$2,500
March 3, 1875	5,000	September 19, 1890	5,000
June 18, 1878	8,000	July 13, 1892	10,000
March 3, 1879	5,000	August 17, 1894	5,000
June 14, 1880	2,000		
March 3, 1881	2,000	Total	56,500
August 2, 1882	2,000		

Money statement.

July 1, 1894, balance unexpended	$1,551.37
Amount appropriated by act of August 17, 1894	5,000.00
November 14, 1894, overpayment refunded	43.40
	6,594.77
June 30, 1895, amount expended during fiscal year	235.65
July 1, 1895, balance unexpended	6,359.12
July 1, 1895, amount covered by uncompleted contracts	6,359.12
Amount (estimated) required for completion of existing project	15,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	15,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of proposals for rock excavation in Otter Creek, Vermont, received in response to advertisement dated September 5, 1894, and opened October 5, 1894, by Capt. Smith S. Leach, Corps of Engineers.

[Approximate quantity of material to be excavated, 1,160 cubic yards.]

No.	Name and address of bidder.	Price bid per yard measured in place.	Amount.
1	Luther Whitney, Keeseville, N. Y	$12.75	$14,790.00
2	Townsend & Johnston, Somers Point, N. J	8.65	10,034.00
3	Rogers & Fitzpatrick, Plattsburg, N. Y	8.11	9,407.60
4	John M. Seward, Albany, N. Y	8.00	9,280.00
5	William James Daly, Ogdensburg, N. Y	6.00	6,960.00
6	Willard Johnson, Fulton, N. Y	9.00	10,440.00
7	Lynch & Hannan, Ogdensburg, N. Y	5.00	*5,800.00

*Lowest bid. Accepted and contract entered into.

Amount available for payment of contractor's estimates for above work, $5,800.

COMMERCIAL STATISTICS.

Name of harbor, Otter Creek, Vermont; nearest light-house, Split Rock; collection district, Vermont.

Arrivals and departures of vessels, 1894.

Character of craft.	Arrivals.		Departures.	
	Number.	Tons.	Number.	Tons.
Unrigged	52	9,025	52	9,025
Sail	27	2,000	27	2,000
Steam tugs	16	1,200	16	1,200
Steam vessels	144	1,150	139	1,100

Total tons of merchandise arrived and shipped, 1894.

Articles.	Shipped.	Arrived.
	Tons.	*Tons.*
Coal	.....	5,100
Iron	600	1,500
Lumber	.....	4,085
Nails	1,250	.....
Kaolin	900	.....
General merchandise	200	400

P P 8.

IMPROVEMENT OF TICONDEROGA RIVER, NEW YORK.

The project for this improvement was adopted in 1891, its object being the formation of a channel of navigable width and a least depth of 8 feet at low water between the falls of Ticonderoga and Lake Champlain, a distance of about 2 miles. (See Report of Chief of Engineers, 1891, page 726.)

The improvement was estimated to cost $42,516, of which amount $16,500 has been appropriated and $26,016 is still due the improvement. The appropriation of September 19, 1890, was expended under contract dated January 12, 1891, with Willard Johnson, of Fulton, N. Y., in dredging 8,132 cubic yards from shoal places near the mouth of the river. Operations commenced May 7 and were completed May 21, 1892. In order to carry out the scheme of improvement the existing channel will require very general widening and deepening.

APPROPRIATIONS.

Act of—	
March 3, 1881	$5,000
August 2, 1882	5,000
August 5, 1886	2,000
August 11, 1888	2,500
September 19, 1890	2,000
Total	16,500

Money statement.

Amount (estimated) required for completion of existing project	$26,016.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	26,016.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

P P 9.

IMPROVEMENT OF NARROWS OF LAKE CHAMPLAIN, NEW YORK AND VERMONT.

The original project for this work was adopted in 1885, and had for its object the removal of such obstructions in the channel between Whitehall, N. Y., and a point a mile below, known as the Elbow, as would afford a least depth of 12 feet with a least width of 150 feet, and the dredging of the channel along Cedar Mountain and across Kenyon Bay so as to afford a least depth of 12 feet and a width of 200 feet. The estimated cost was $80,000.

In 1886 and 1888 appropriations aggregating $45,000 were made, with which sum, owing to very low prices, the project was completed, leaving a balance in hand of over $2,500.

In the winter of 1889–90 a survey was made from Whitehall to Benson Landing, on which was based a supplementary project involving 92,000 cubic yards of dredging at an estimated cost of $21,000, distributed among three points, known as South Bay, Beacon No. 3, and Chiltons Bends. In the act of July 13, 1892, the sum of $18,500 was appropriated, making, with the balance in hand, substantially the amount estimated for the execution of this project. Bids for the work were opened September 8, 1892, and the award made to Lynch & Hannan, of Ogdensburg, N. Y., the lowest responsible bidders, at the rate of 15 cents per cubic yard. Operations commenced in July and were completed in October, 1893. The total amount of material removed was 89,818 yards.

No complaints of obstruction to navigation have been made, but inquiries develop a strong probability that there are points where part, and perhaps all, of the balance on hand can be applied with distinct advantage. When such points have been determined, a supplementary project will be submitted.

APPROPRIATIONS.

Act of—	
August 5, 1886	$30,000
August 11, 1888	15,000
July 13, 1892	18,500
Total	63,500

Money statement.

July 1, 1894, balance unexpended	$5,598.81
July 1, 1895, balance unexpended	5,598.81

COMMERCIAL STATISTICS.

Number of boats, tows, and tonnage that passed into and out of Whitehall Harbor, New York, during the year 1894.

Whole number of tows	170
Average number of boats in a tow	18
Total boats towed	3,115
Number of tons to a boat	160
Total tons carried	489,600
Value of cargoes:	
Arrived	$3,613,475
Departed	367,546

P P 10.

PRELIMINARY EXAMINATION OF WADDINGTON HARBOR, NEW YORK.

[Printed in House Ex. Doc. No. 18, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report dated October 27, 1894, of Capt. S. S. Leach, Corps of Engineers, giving results of preliminary examination of harbor of Waddington, N. Y., required by river and harbor act of August 17, 1894.

In view of the facts as stated it is the opinion of Captain Leach, concurred in by the division engineer, Col. Henry L. Abbot, Corps of Engineers, and by this office, that the harbor of Waddington is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. S. S. LEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., October 27, 1894.

GENERAL: Pursuant to instructions contained in Department letter of August 20, 1894, I have the honor to submit the following report of a preliminary examination of the "harbor of Waddington, N. Y."

Waddington is a village of less than 1,000 inhabitants, situated on the St. Lawrence River 18 miles below Ogdensburg. Full information as to the natural conditions of the harbor and the work heretofore done there may be found in a report of Assistant Engineer John C. Churchill, jr., printed on pages 2415 and 2416 of the Report of the Chief of Engineers for 1887, and to which I refer.

The dam across a branch of the St. Lawrence at Waddington affords an excellent water power. The dam was built early in the century, and twenty to thirty years ago was covered with mills from end to end. Manufacturing interests have constantly declined, however, owing to the lack of rail transportation, the nearest station being 10 miles distant. At the present time but two small plants are running, a local grist mill at one end of the dam and a creamery at the other. The total freight movement of the port does not exceed 3,000 tons per annum. Nearly the whole of this is carried by a small boat plying

daily between Waddington and Ogdensburg. It uses the upper harbor, entering at the head of Ogdens Island. The upper harbor was dredged to 12 feet in 1875, and in 1886 Mr. Churchill found that depth unimpaired. It is probable that it still exists, and it is certain that there is ample depth for any vessel entering or likely to enter the harbor.

In view of these facts, I am of the opinion that the harbor of Waddington is not worthy of improvement by the General Government.

Waddington is a port of entry in the collection district of Oswegatchie. The nearest United States light-house is at Ogdensburg and the nearest defensive work at Rouse Point, N. Y.

Very respectfully, your obedient servant,

SMITH S. LEACH,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Henry L. Abbot, Corps of Engineers, Division Engineer, Northeast Division.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, October 29, 1894.

Respectfully forwarded to the Chief of Engineers, U. S. Army.

For the reasons stated I concur with Captain Leach in regarding the harbor of Waddington, N. Y., as unworthy of improvement by the General Government.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

P P 11.

PRELIMINARY EXAMINATION OF MISSISQUOI RIVER, VERMONT, PARTICULARLY BETWEEN THE VILLAGE OF SWANTON AND THE LAKE.

[Printed in House Ex. Doc. No. 19, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated October 27, 1894, by Capt. Smith S. Leach, Corps of Engineers, giving results of preliminary examination of Missisquoi River, Vermont, "particularly between the village of Swanton and the lake," as directed by the river and harbor act of August 17, 1894.

It is the opinion of Captain Leach that this locality is worthy of improvement; the division engineer, Col. Henry L. Abbot, Corps of Engineers, reports that he thinks the facts stated in the accompanying report "warrant a survey and project from which to determine whether the cost will be sufficiently small to make the river worthy of improvement by the General Government." I concur in the opinion of the division engineer.

It is estimated that the necessary survey may be made for $500.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. S. S. LEACH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Burlington, Vt., October 27, 1894.

GENERAL: Pursuant to instructions contained in Department letter of August 20, 1894, I have the honor to submit the following report of a preliminary examination of "Missisquoi River, particularly between the village of Swanton and the lake."

The Missisquoi River rises in the northernmost spurs of the Green Mountains, near the Canada line, and after flowing in a westerly direction to near the village of Swanton turns and flows a little west of north emptying into Missisquoi Bay by three branches. Missisquoi Bay is the northernmost part of Lake Champlain, and extends some distance into Canadian territory. It is not on the route of through navigation in the lake, being separated from the Richelieu River by a peninsula called the "Alburg Tongue." Missisquoi Bay has a good navigable connection with the lake, however, which now enables any vessel navigating Lake Champlain to reach the bar at the mouth of Missisquoi River at any stage of water.

At Swanton, 6 miles from the mouth, the Missisquoi flows over a ledge of rock on which a water-power dam is built, making a complete interruption of navigation at that point. For this reason no attention was given to the portion of the river above Swanton. Below Swanton the Missisquoi is a fair-sized stream, flowing between low but well-defined and permanent banks, with a prevailing channel depth of 4 to 6 feet at extreme low water. The discharge, though considerable in the driest seasons, is not a factor in the maintenance of navigable depth, since the fall is very slight and backwater from the lake would fill the channel if the discharge of the river were cut off entirely. In fact, all stages of this part of the river depend more on the lake level than upon discharge.

The prevailing depths of 4 to 6 feet at low water are interrupted at several localities by shoals on which the depth at lowest stages is but a few inches, making all commercial boating impossible. These shoals are not numerous, are not long, and, so far as could be ascertained, offer no material difficult to excavate. To cut through them, without any general deepening at all, would give a depth of 4 feet at extreme low water. This in itself would be a very great improvement.

The commerce of the Missisquoi River, present and prospective, is that of Swanton, a prosperous village of 3,500 inhabitants. Swanton is situated at the head of the portion of the river under consideration at the junction of the Vermont Central and Boston and Maine railroads. The water power before mentioned has developed a considerable manufacturing interest, which has not reached its limit, as there is unemployed power estimated at 1,500 horsepower under a minimum flow. The establishments now running include a marble mill, grain elevator, grist, saw, and planing mills, machine shop, and some minor plants.

The volume of commerce for the past year, as reported by Mr. T. M. Tobin, secretary of the Swanton Board of Trade, was 3,900 carloads shipped and 605 carloads received, a total of 4,505 cars, or approximately 70,000 tons. Much of this freight is heavy and bulk goods, especially adapted to water transportation, and being afloat in lake bottoms could be discharged at the village if the depth of water sufficed. Much is so discharged when the stage of water serves, but as navigation is closed by ice five months in the year and by low water

for three months more, the river is of but little service now. There is an occasional year when there is no navigation and an occasional year in which there is no interruption, but these can not be foreseen, and hence in arranging for materials the year's supply must be boated in in four months or else brought in by rail.

As a résumé of this report it may be stated that a substantial improvement of the Missisquoi River between Swanton and the lake can probably be effected at relatively small cost, and that a very respectable volume of commerce will be directly benefited by such improvement. I therefore state that in my opinion the locality is worthy of improvement by the General Government, and I submit an estimate of $500 as the amount which will enable me to make a survey and report, including a project, with estimate of the cost of the improvement proposed.

Swanton is in the collection district of Burlington. The nearest light-house is at the foot (north end) of Isle La Motte, and the nearest defensive work is at Rouse Point, New York.

Very respectfully, your obedient servant,

SMITH S. LEACH,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. Henry L. Abbot, Corps of Engineers, Division Engineer, Northeast Division.)

[First indorsement.]

NORTHEAST DIVISION ENGINEER OFFICE,
New York, October 29, 1894.

Respectfully forwarded to the Chief of Engineers, United States Army. I think that the facts herein stated warrant a survey and project from which to determine whether the cost will be sufficiently small to make the river worthy of improvement by the General Government.

HENRY L. ABBOT,
Colonel of Engineers, Bvt. Brig. Gen., U. S. A.,
Division Engineer.

APPENDIX Q Q.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENT.

1. Oakland Harbor, California.

EXAMINATIONS.

2. Sunken rocks off Fort Point, San Francisco Harbor, California.
3. Mile Rocks, San Francisco Harbor, California.
4. Arch Rock, San Francisco Harbor, California.
5. Noonday Rocks, San Francisco Harbor, California.
6. Blossom Rock, San Francisco Harbor, California.
7. Two Mission Rocks, San Francisco Harbor, California.
8. Shag Rock, San Francisco Harbor, California.
9. Anita Rock, San Francisco Harbor, California.
10. Invincible Rock, Whiting Rock, and Fifteen-Foot Rock, known as The Brothers, near Point San Pablo, San Francisco Bay, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 3, 1895.

GENERAL: I have the honor to transmit herewith the annual report upon work of improving harbor at Oakland, Cal., for the year ending June 30, 1895. * * *

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

Q Q 1.

IMPROVEMENT OF OAKLAND HARBOR, CALIFORNIA.

OPERATIONS OF THE YEAR.

The field operations were under the immediate charge of the assistant engineer, L. J. Le Conte, with the assistance of an inspector during part of the year. The field work consisted in laying out and supervising the operations of contractors, in monthly surveys and estimates, in

a hydrographic survey at the close of the year, and in miscellaneous work.

The operations were conducted under contracts. At the beginning of the year a contract made with John Hackett October 8, 1892, for the channel in front of Oakland was not half fulfilled, the time of performance having been extended from April 15 to October 15, 1894. The time for fulfillment was afterwards extended to February 28, 1895, at which date operations were terminated, with a total of 227,081 cubic yards, of which 117,316 cubic yards were dredged and placed ashore during the year.

But one contract was made during the year, and that was with the San Francisco Bridge Company to include two separate pieces of work, as follows: (1) To open a passage 100 feet wide and 8 feet deep, at low water, from the head of the basin into the canal, the excavated material to be placed ashore. The estimated quantity of material to be moved was 30,000 cubic yards, and the price named in the contract was 37 cents per cubic yard. (2) The second item of the contract was to extend the 20-foot channel, having a width of 300 feet, to the westward for a distance of 6,000 feet, more or less, the material dredged to be safely impounded. The amount of dredging involved in this item is 400,000 cubic yards, more or less, and the price named in the contract is 19.9 cents per cubic yard.

The date of the contract is December 10, 1894.

The work of dredging the passage into the canal was begun on December 18, 1894, and finished on January 20, 1895, work being conducted day and night.

The amount dredged was 29,208 cubic yards.

The second work provided in the contract, namely, the extension of the 20-foot channel, was begun on January 28, and was prosecuted with some intermissions to the close of the year, with the accomplishment of 203,493 cubic yards, which amount is considerably in advance of the contract requirements. The date set in the contract for fulfillment is August 1, 1896. It is probable that this date will be anticipated by a number of months.

The place of deposit is in the angle of junction of the south jetty with the shore, the spoil being retained by the jetty on the north, and on the weather side by a substantial timber bulkhead, supported by a heavy line of riprap stone. The conveyance is by water pumped through pipes, and the mean distance has so far been 1,230 feet. The material in its upper layers is to a great extent sand, with some mud; the lower layers consist of blue clay, with some hardpan, and in places of mud.

This kind of dredging by hydraulic machines and appliances is practically the same as that first applied on this work to river and harbor improvements many years ago, often described in annual reports.

The following generalization of fuel expenditure in digging and transporting hard and soft material, transported 1,000 to 1,200 feet, in 16-inch pipes to a mean height above water level of 9 feet, may be of interest. Amount of anthracite coal per cubic yard dug and transported is, for soft material, $5\frac{1}{3}$ pounds, and for hard material $12\frac{1}{2}$ pounds, material being measured in place. The variation in fuel is, of course, mainly due to resistance in cutting, the transportation fraction not varying to nearly the same extent.

PRESENT CONDITION OF WORKS.

A hydrographic survey made at the close of the year of the channel from Brooklyn, near the head of the basin, to a point of 24 feet depth in San Francisco Bay reveals this condition of affairs: The channel in

and about Brooklyn has lessened in depth from 1 to 1½ feet, leaving a present depth of 6 to 7 feet. For the remainder of the length of channel the dredged and natural depths have been well preserved, with unimportant exceptions. Beginning at Oakland, there is for 2,200 feet a low-water depth of 20 feet, and for the next 1,800 feet, a depth of 18 to 19 feet. At this point the present contract work begins, and includes 3,300 in length of channel 20 feet deep. It is expected to continue this depth for about 3,000 feet under the existing contract with the San Francisco Bridge Company. There will remain after the execution of this contract a length of 8,500 feet to be deepened by an average of 6 feet in order to extend the full depth to San Francisco Bay and also the cleaning up of about 1,800 feet already mentioned, by taking up 1 to 2 feet of material. When this work shall have been done, a channel 300 feet wide, with about 24 feet depth at ordinary high water, will connect Oakland with San Francisco Bay and the ocean. This work could be finished in eighteen months.

The bridge spanning the canal at Park street, Alameda, is provided with a draw, which, however, is not used, there being no navigation as yet. The bridge needs to be painted, and also needs some repair to the machinery which controls the draw opening.

No work was done on either jetty during the year. The deposit of spoil in the angle of the south jetty with the shore, already mentioned, stands several feet above the high-tide level, and serves a good purpose in arresting the littoral movement of sand, which has of late years overtopped the jetty and deposited within the lines.

The jetties have not undergone any change during the year.

The general condition of the improvement may be expressed in the statement that vessels drawing 18 or 19 feet of water can reach the front of Oakland, there having, however, been no particular change in this respect during the year.

A diminution of the yearly freight, and a very considerable increase in the passenger travel between the jetties will be noticed in the table of statistics. The first-named circumstance is due in part to a general depression, and again to the withdrawal of several large manufacturing enterprises.

The increased travel is due to a considerable reduction in amount of fares per journey.

FUTURE OPERATIONS.

There remain unexecuted the following-described pieces of work necessary to finish the approved project for this harbor, one or more of which can be undertaken in the coming year provided sufficient funds shall be appropriated, namely:

Completion of 20-foot channel to San Francisco Bay.

Extension of the south jetty 550 feet.

Excavation of the canal, with bridges and dam in San Leandro estuary.

Extension of deep water to San Francisco Bay, and finishing of the south jetty are regarded as, at the present, of greater relative importance.

Appropriations for improving harbor at Oakland, Cal.

June 23, 1874	$100,000	July 5, 1884	$139,600
March 3, 1875	100,000	August 5, 1885	60,000
August 4, 1876	75,000	August 11, 1888	350,000
June 18, 1878	80,000	September 19, 1890	250,000
March 3, 1879	60,000	July 13, 1892	150,000
June 14, 1880	60,000	August 17, 1894	100,000
March 3, 1881	60,000		
August 2, 1882	200,000	Total	1,784,600

Money statement.

July 1, 1894, balance unexpended		$64,995.65
Amount appropriated by act of August 17, 1894		100,000.00
		164,995.65
June 30, 1895, amount expended during fiscal year		102,836.27
July 1, 1895, balance unexpended		62,159.38
July 1, 1895, outstanding liabilities	$9,515.45	
July 1, 1895, amount covered by uncompleted contracts	39,104.89	
		48,620.34
July 1, 1895, balance available		13,539.04
Amount (estimated) required for completion of existing project		741,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		300,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of bids for dredging channel and opening west end of tidal canal, Oakland Harbor, California, opened at 11 a. m. November 8, 1894, in accordance with advertisement dated October 8, 1894.

Name and address of bidder.	Channel.			Tidal canal.		
	Price per cubic yard.	Number of cubic yards that can be dredged with money available.	Amount.	Price per cubic yard.	Number of cubic yards that can be dredged with money available.	Amount.
San Francisco Bridge Co., San Francisco, Cal	$0.19 2/10	427,000	$84,973	$0.37	30,000	$11,100
Will S. Bliss, San Francisco, Cal	.33 1/3	255,000	85,000	.33 1/3	33,300	11,100
Pacific Coast Dredging and Reclamation Co., San Francisco, Cal	.41	207,000	84,870	.49	22,600	11,074
Bowers Pacific Dredging Co., San Francisco, Cal	.40	212,500	85,000	1.50	7,400	11,100

Bid of San Francisco Bridge Company accepted.

COMMERCIAL STATISTICS.

The following is a tabulated statement showing increase in traffic by vessels and steamers through the channel way between the jetties during different calendar years.

The classified freight, embracing staple articles, carried by sail, during 1894, amounts 309,350 tons, composed as follows:

	Tons.
Coal	143,000
Grain and flour	7,600
Lumber	86,400
Building materials	50,580
Sundries	21,770
Total	309,350

The gross amount is a trifle more than last year's total. The increase in passenger traffic at the Broadway Ferry is some 50,000 passengers over and above last year's report, and comprises 554,932 passengers.

Year.	Traffic by steam ferries.				Traffic by vessels.		
	Number.	Trips.	Passengers.	Freight.	Number.	Register.	Freight.
				Tons.		*Tons.*	*Tons.*
1874	1	600	None.	60,000	1,415	70,750	94,300
1890	3	8,600	100,000	1,925,957	2,153	213,971	393,478
1891	3	8,600	100,000	2,259,086	2,310	232,706	437,923
1892	3	8,600	96,000	2,202,170	2,277	223,148	443,011
1893	5	10,521	506,125	2,142,460	1,686	195,090	306,865
1894	4	9,561	554,932	2,119,267	1,741	175,750	300,350

The following comparative grand totals of traffic through the jetty channel show the growth of water transportation in the past twenty years:

General traffic.	1874: Before improvement.		1894: After improvement.	
	Passengers.	Freight.	Passengers.	Freight.
		Tons.		*Tons.*
By ferries	None.	60,000	554,932	2,119,267
By vessels	None.	94,000	.....	309,350
Total	.....	154,300	554,932	2,428,617

Q Q 2.

PRELIMINARY EXAMINATION OF SUNKEN ROCKS OFF FORT POINT, IN SAN FRANCISCO HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 25, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of preliminary examination of sunken rocks off Fort Point, in San Francisco Harbor, California, provided for by the river and harbor act of August 17, 1894.

Colonel Mendell states that there is no good reason to incur the expense of the removal of these rocks, and I am of the opinion that the improvement is not worthy of being undertaken by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 25, 1894.

GENERAL: The following is a report of a preliminary examination required by section 10 of the act of August 17, 1894, so far as relates to the sunken rocks off Fort Point, San Francisco Harbor:

These rocks are situated on or close to a circumference of 400 feet radius, described from the extremity of Fort Point as a center. The

principal rock has 11 feet of water over it at low tide. It lies just inside of the 3-fathom curve, and has no water deeper than 3 fathoms inside of it, with 14 feet close by. The rock is, by the best information, 200 feet in width. It lies outside of the channel and in such shallow water that no course of a vessel would ever be knowingly laid near it.

There are two other rocks to the westward, in shoal water, having 7 to 9 feet depth over them. No one of these rocks is considered to be dangerous, and if they were all removed the adjacent bottom would be little less dangerous than the rocks themselves. For these reasons it is considered that there is no good reason to incur the considerable expense required to remove them. A special survey of them is not recommended.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 3.

PRELIMINARY EXAMINATION OF MILE ROCKS, SAN FRANCISCO HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated October 11, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of a preliminary examination of the Mile Rocks, San Francisco Harbor, California, provided for by the river and harbor act of August 17, 1894.

It is the opinion of Colonel Mendell that, under existing circumstances, the removal of these rocks is not a worthy improvement, and in this opinion I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., October 11, 1894.

GENERAL: I have the honor to make report of the preliminary examination required by section 10 of the act of August 17, 1894, in reference to the Mile Rocks, situated near the southern shore of the entrance to this harbor, and just within the line of the heads.

The Mile Rocks lie three-eighths of a mile north of the main south shore, which is high and bold. There is 12 fathoms of water north of them, close in, and between them and the shore there is a passage of

deep water that is now not used by deep-draft vessels, it being known to be hazardous by reason of the existence of known rocks, and general want of knowledge as to others said to be present.

It appears that this channel has not been carefully surveyed.

If the two rocks known as the Mile Rocks were removed there would remain the following known dangers, namely: A sunken rock with 6 feet of water upon it, about 130 yards easterly of the outer mile rock, and about 75 yards from the inner rock. In the same neighborhood, only a few yards distant, is another rock with 14 feet of water. Other rocks are known to exist within 200 to 300 yards of the shore, and in the channel between these rocks and the Mile Rocks there is said to be a reef of 18 feet of water.

The Mile Rocks are within 100 feet of each other. They stand about 20 feet above the water. They are quite conspicuous, and may be looked upon as beacons which warn the sailor against the hidden dangers already mentioned. Indeed, it may be held with some propriety that their removal alone would make the case worse for ships than it now is.

These rocks are not in the main channel, which is about $1\frac{3}{4}$ miles wide between them and Point Bonita.

Under existing circumstances the removal of the Mile Rocks is not considered to be a worthy improvement. When the vicinity shall come to be thoroughly explored and all dangers shall be made manifest the question of removal can be well considered.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 4.

PRELIMINARY EXAMINATION OF ARCH ROCK, SAN FRANCISCO HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated October 11, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of a preliminary examination of Arch Rock, in San Francisco Harbor, California, provided for by the river and harbor act of August 17, 1894.

It is the opinion of Colonel Mendell, concurred in by this office, that if the rock is found upon survey to be removable at moderate cost it is a worthy improvement, but its conspicuousness places it out of the class of most dangerous obstructions.

The necessary survey is estimated to cost $500.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., October 11, 1894.

GENERAL: I have the honor to make report of the preliminary examination required by section 10 of the act of August 17, 1894, of Arch Rock, situated in San Francisco Harbor two-thirds of a mile west of the northern end of Alcatraz Island. It lies one-half mile north of the course laid on the Coast Survey charts to be followed by a vessel entering the harbor.

The rock stands full 30 feet above the water. The visible portion of it is about 50 feet long and from 10 to 20 feet in width. It is a conspicuous object, both from its size and whiteness. It is in no sense a hidden danger. Northwesterly from the rock, 100 yards distant, there are 3 fathoms of water. On the southerly side, at a distance of 100 yards, there is a rocky bottom with 22 feet of water.

These indications suggest that the area of rock may be very large which, if so, necessitates a great outlay for its removal.

The flood tide makes toward the rock, and vessels entering in fog, or if sail vessels, with light wind, may drift upon it. A number of vessels have been either wrecked or injured by getting on the rock.

If the rock is found upon survey to be removable at moderate cost it is regarded as a worthy improvement, but its conspicuousness places it out of the class of most dangerous obstructions.

The survey needs to embrace the surrounding bottom to the depth of 5 fathoms. Such a survey is estimated to cost $500.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 5.

PRELIMINARY EXAMINATION OF NOONDAY ROCKS, SAN FRANCISCO HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 21, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of preliminary examination of Noonday Rocks, San Francisco Harbor, California, provided for by the river and harbor act of August 17, 1894.

It is the opinion of Colonel Mendell, concurred in by this office, that the harbor is worthy of this improvement, and he estimates that $3,000 will be required for a survey necessary for the preparation of plan and estimate for the removal of these rocks.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 21, 1894.

GENERAL: The following is a report of a preliminary examination of Noonday Rocks, required by section 10 of the act of Congress August 17, 1894, made from a study of available data:

These rocks lie near together about 20 miles off the coast in the open sea. But one rock is definitely known and located; it lies 3 miles nearly west of the northwesterly islet of the Farallones group.

The first and for a time the only known Noonday Rock was removed in 1875 to a depth of 8 fathoms. It is probably no longer a danger. At the time of this removal two other rocks were found near by, one of which was large, in $2\frac{1}{2}$ fathoms of water. In 1886 the Coast Survey made an examination of the vicinity, which resulted in finding but one rock in the position above described with a minimum depth of 4 fathoms upon it. It is described in the Coast Pilot as a reef about 60 yards long east and west within the $4\frac{1}{2}$-fathom lines. It is marked by a large buoy.

The large rock noted by Lieutenant Weeden, in 1875, was estimated by him to be 70 by 30 feet at the 4-fathom line.

The difficulty of finding in several fathoms of water small submerged rocks, too small or sharp to have their positions indicated by breakers, is well known. A careful sounding repeated more than once may fail in discovering them. The fact of nondiscovery in one trial by soundings, however carefully made, can not be taken as proof of nonexistence of such a rock. If the whole area be dragged or swept by a bar held horizontally without finding rocks the evidence is good for the stated depth.

The exposure of this locality is considerable. It is swept most of the time by long swells, which make for the time a descent by diver impracticable. For several months in the year surveys are impracticable by reason of fogs.

It certainly is desirable that these rocks, one or several as may be proved, lying as they do in the approach to the harbor entrance, should be removed to a safe depth, which to be safe under the sea exposure ought to be 8 or 10 fathoms.

The commerce of San Francisco, by its magnitude and importance, deserves to have these dangers explored, located, and surveyed in detail so that the cost of removal may be estimated.

The harbor of San Francisco is worthy of this improvement.

The cost of such a survey is difficult to estimate, mostly by reason of the uncertainty of sea and weather. At some seasons a survey is plainly impracticable. Probably the best chance of success may be found in October.

The survey must explore the ground with such closeness as to make it certain that all the rocks shall be discovered. The rocks must then be surveyed in detail.

Three thousand dollars is suggested as a reasonable estimate of cost of survey. If circumstances prove favorable the cost may be less.

Reference may be made to volume 2, Report of Chief of Engineers, 1875, page 715 et seq.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 6.

PRELIMINARY EXAMINATION OF BLOSSOM ROCK, SAN FRANCISCO HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 21, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of preliminary examination of Blossom Rock, San Francisco Harbor, California, provided for by the river and harbor act of August 17, 1894.

It is the opinion of Colonel Mendell, concurred in by this office, that the harbor is worthy of this improvement, and he estimates that $250 will be necessary for the survey required for the preparation of plan and estimate of cost of the improvement.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 21, 1894.

GENERAL: The preliminary examination of Blossom Rock, San Francisco, required in section 10 of the act of Congress of August 17, 1894, has been made by chart of the most recent survey. This chart shows a minimum depth of something less than 23 feet at mean low stage of tide. The original depth over the rock was about 6 feet. About twenty years ago it was excavated, as appears by official reports, to a depth of 24 feet. Since that date one or more vessels have touched upon it. It is now marked by a buoy. It is situated near the path of wheat vessels coming from Port Costa. The minimum depth over the rock at low water of spring tides does not exceed 21 feet.

The survey required to determine cost of removal will need to discover the portion which is rock in place and the portion which is broken rock, due to the great explosion of powder which broke it up. If the work of further removal shall be undertaken, it should be carried to the depth of 30 feet at mean low-water mark, which corresponds to about 28 feet at low water of spring tides.

This harbor is considered, by virtue of its large seagoing commerce, to be worthy of improvement by the further removal of Blossom Rock, always provided that the cost shall not prove to be excessive.

It is estimated that the sum of $250 will be needed for a thorough examination and survey, made for the purpose of estimating the cost of the improvement.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 7.

PRELIMINARY EXAMINATION OF TWO MISSION ROCKS, SAN FRANCISCO HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 26, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of preliminary examination of Two Mission Rocks, San Francisco Harbor, California, provided for by the river and harbor act of August 17, 1894.

It is the opinion of Colonel Mendell, concurred in by this office, that the harbor is worthy of this improvement, and he estimates that a survey necessary to the preparation of plan and estimate of improvement will cost $200.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 26, 1894.

GENERAL: The following is a report of the preliminary examination required in section 10, act of August 17, 1894, so far as relates toTwo Mission Rocks, situated in San Francisco Harbor.

They are here known as Mission Bay Rock and as Sonoma Rock. They have about 13 feet of water over them at low tide.

They are situated near the city water front, in a thoroughfare for vessels, and therefore constitute notable dangers. One or more vessels have touched them. They are now marked by buoys.

These facts seem to demonstrate the propriety and desirableness of their removal.

This harbor is, on account of its large commerce, deemed worthy of this improvement.

It is estimated that a suitable survey of these rocks can be made for $200.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 8.

PRELIMINARY EXAMINATION OF SHAG ROCK, SAN FRANCISCO HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 21, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of preliminary examination of Shag Rock, San Francisco Harbor, California, provided for by the river and harbor act of August 17, 1894.

It is the opinion of Colonel Mendell, concurred in by this office, that the harbor is worthy of this improvement, and he estimates that $50 will be sufficient to obtain the further information necessary to the preparation of plan and estimate of cost of the removal of this rock.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 21, 1894.

GENERAL: The preliminary examination of Shag Rock, San Francisco Harbor, required by section 10 of the act of Congress of August 17, 1894, has been made by study of a chart in detail, made by the Engineer Department some years ago.

This rock stands about 4 feet above high-water mark. Its upper surface has an area of about 25 square feet. Its area at 30 feet depth is not far from 6,000 square feet. It lies in the path of the ferryboats connecting this city and Sausalito, with deep water on all sides. In foggy weather and at night it is a danger. If removed there ought to be 30 feet of water over it at mean low water.

The chart made by the Engineer Department needs to be supplemented by additional soundings. It is estimated that $50 will be sufficient to obtain further information required for an estimate of cost of removal.

By reason of the danger to lives, vessels, and cargoes due to the existence of this rock, the opinion is expressed that San Francisco Harbor is worthy of improvement by removal of this rock.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 9.

PRELIMINARY EXAMINATION OF ANITA ROCK, SAN FRANCISCO HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated September 21, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of preliminary examination of Anita Rock, San Francisco Harbor, California, provided for by the river and harbor act of August 17, 1894.

It is the opinion of Colonel Mendell, concurred in by this office, that the harbor is worthy of this improvement, and he estimates that a survey necessary for the preparation of plan and estimate for the removal of this rock can be made for $100.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., September 21, 1894.

GENERAL: The following is a report of a preliminary examination of Anita Rock, in San Francisco Harbor, required by section 10 of the act of Congress of August 17, 1894, and made from a study of official charts and other available data.

This rock does not lie in the main thoroughfare of vessels. It is situated in a bight of the Presidio shore line, within 300 yards of the shore, and about a mile east of Fort Point. It shows at some low tides. It is marked by an iron spindle set in the rock and standing 24 feet above high water. The spindle carries an iron cage 5 feet in diameter, painted in stripes; above the cage is a glass globe.

There is deep water on both sides. The rock is in a certain degree a danger. It is not, in comparison with some other rocks, a danger of great magnitude, yet the harbor will be better for its removal.

The cost of a survey sufficient for estimate for removal can be made for $100.

The harbor of San Francisco is, by reason of its great commerce, considered to be worthy of this improvement.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

Q Q 10.

PRELIMINARY EXAMINATION OF INVINCIBLE ROCK, WHITING ROCK, AND FIFTEEN-FOOT ROCK, KNOWN AS THE BROTHERS, NEAR POINT SAN PABLO, SAN FRANCISCO BAY, CALIFORNIA.

[Printed in House Ex. Doc. No. 51, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated October 11, 1894, by Col. G. H. Mendell, Corps of Engineers, of the results of a preliminary examination of Invincible Rock, Whiting Rock, and Fifteen-Foot Rock, known collectively as The Brothers, near Point San Pablo, San Francisco Bay, California, provided for by the river and harbor act of August 17, 1894.

It is the opinion of Colonel Mendell, concurred in by this office, that, on account of the magnitude of the commerce concerned, San Francisco Harbor is worthy of the improvement due to the removal of these rocks, provided that a survey shall demonstrate this to be a reasonable proposition.

Colonel Mendell estimates that $300 will be required for survey and estimate of cost of this improvement.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., October 11, 1894.

GENERAL: I have the honor to make report of a preliminary examination required in section 10 of the act of August 17, 1894, of the group of rocks lying off the islets, known as The Brothers, near Point San Pablo, San Francisco Bay.

There are three rocks in this group, named "Invincible," "Whiting," and "Fifteen-Foot Rock." They lie in a line nearly north and south, a half mile long.

INVINCIBLE ROCK.

This rock lies near a mile from the shore, and a half mile from The Brothers Light, in mid-channel, with 11 to 15 fathoms on each side and 6 to 7 fathoms north and south of it. The Coast Survey chart shows a depth of 8 feet upon it at low water. It is marked by a danger buoy.

WHITING ROCK.

This rock lies 200 to 300 yards north of Invincible Rock, and is about two-thirds of a mile from shore. It has 12 feet of water upon it, with 8 to 10 fathoms on each side of it. It is marked by a danger buoy.

FIFTEEN-FOOT ROCK.

This rock lies about 500 yards north from Whiting Rock and about 400 yards nearly west of the East Brother Light-House. Its name indicates the depth of water over it. It, like the two rocks previously mentioned, lies in mid-channel, with deep water on all sides of it.

All of these rocks are in a channel which carries nearly all the foreign grain commerce of this port.

They are all dangers to navigation, and for this reason, and on account of the magnitude of the commerce concerned, San Francisco Harbor is considered worthy of the improvement due to their removal, provided that a survey shall demonstrate this to be a reasonable proposition.

It is estimated that the sum of $300 will be required for survey and estimate of cost of removal of the three rocks, or $150 for a proper survey of one of them.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

APPENDIX R R.

IMPROVEMENT OF RIVERS AND HARBORS IN SOUTHWESTERN ARIZONA AND IN CALIFORNIA SOUTH OF SAN FRANCISCO.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Napa River, California.
2. Redwood Creek, California.
3. San Luis Obispo Harbor, California.
4. Wilmington Harbor, California.
5. San Diego Harbor, California.
6. Colorado and Gila rivers, at Yuma, Ariz.

EXAMINATIONS.

7. Harbor of El Moro, California.
8. San Rafael Creek, California.
9. Suisun Creek, California.
10. Napa River, California, between North and South Vallejo.

HARBOR LINES.

11. Wilmington Harbor, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 6, 1895.

GENERAL: I have the honor to transmit herewith reports upon the works of river and harbor improvements under my charge for the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

R R 1.

IMPROVEMENT OF NAPA RIVER, CALIFORNIA.

The approved project for the improvement of this river contemplates the removal of snags and leaning trees dangerous to navigation and the deepening of the channel over the bars between Vernon Mill and Carr Bend, in the immediate vicinity of Napa City.

The last work upon the river was done in 1891, when the river was cleared of snags and a good channel dredged through the bars along the entire length of the city front.

An examination made this spring for the purpose of obtaining data upon which to base specifications for additional work showed that the dredged channel had refilled, owing to the winter floods in the river, and that the stream is in as bad a condition as it was before the improvement was commenced.

No permanent improvement of the river can be effected, as a channel dredged one year is liable to be obliterated by the floods of the succeeding winter.

It is considered that to keep the river in a good navigable condition appropriations should be made so as to permit dredging to be continued from year to year. Ordinary tides rise 5 feet and spring tides about 7, so that with a comparatively small amount of work it is possible to maintain the river in a good condition for the class of vessels that are engaged in the trade.

For continuing the dredging with the appropriation of $4,000, made by the river and harbor act of August 17 last, specifications were issued and proposals invited by circular letter sent to the different firms owning dredging plants at San Francisco and vicinity. This method was adopted as a matter of economy, as the appropriation being small it was considered advisable to expend as much of it as possible upon the work itself. Evan Williams was the lowest bidder, as shown by the abstract herewith, and a contract was entered into with him June 17, 1895, to dredge certain bars and projecting points at a price of 29 cents per cubic yard. Work will commence in July and will be completed in sixty days.

The estimated cost of the improvement made in 1885 was $27,500, of which $21,500 has been appropriated as follows:

Act of—	
August 11, 1888	$7,500
September 19, 1890	10,000
August 17, 1894	4,000

The total amount expended to close of fiscal year, including outstanding liabilities, is $17,491.33.

Money statement.

July 1, 1894, balance unexpended	$19.35
Amount appropriated by act of August 17, 1894	4,000.00
	4,019.35
June 30, 1895, amount expended during fiscal year	10.68
July 1, 1895, balance unexpended	4,008.67
July 1, 1895, amount covered by uncompleted contracts	3,500.00
July 1, 1895, balance available	508.67
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	6,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

Abstract of bids for dredging Napa River, California, called for by advertisement of May 1, 1895, and opened at 11 a. m. May 31, 1895, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers.

No.	Name of bidder.	Price per cubic yard.
		Cents.
1	John Hackett	32
2	Evan Williams	29

COMMERCIAL STATISTICS.

[Furnished by Capt. N. H. Wulff, Napa City, Cal.]

Articles.		1884.	1894.
Merchandise, general, received and shipped	tons	22,800	18,990
Coal, received and shipped	do	5,000	10,000
Hay, received and shipped	do	2,000	5,500
Grain, received and shipped	do	3,000	9,800
Lumber, received	do	18,333	5,548
Wine, received and shipped	do	7,500	13,420
Miscellaneous freight, received and shipped	do	5,936	6,175
Total		64,569	69,433
Steamers		2	2
Tonnage		176	700
Trips by steamers		.....	Daily.

No new lines of transportation were established during the year.

R R 2.

IMPROVEMENT OF REDWOOD CREEK, CALIFORNIA.

There are no funds on hand available for this work, and it is not contemplated to continue the improvement. Under appropriations made for Redwood Harbor and Redwood Creek the channel was dredged several times, but it refilled owing to local causes. It is not possible to maintain a channel except by constant dredging.

Should the commerce of Redwood City justify the expenditure, appropriations may be needed in the future to continue the improvement.

The total amount appropriated for dredging at Redwood was $23,400, as follows:

Redwood Harbor:
- Act of July 5, 1884 ..... $3,000
- Act of August 5, 1886 5,000
- Act of August 11, 1888 7,400

Redwood Creek:
- Act of September 19, 1890 8,000

The total amount has been expended.

This work is in the collection district of San Francisco.

Money statement.

July 1, 1894, balance unexpended	$13.51
July 30, 1895, amount expended during fiscal year	13.51

R R 3.

IMPROVEMENT OF SAN LUIS OBISPO HARBOR, CALIFORNIA.

The approved project is to construct a breakwater on Whaler Reef extending from Point San Luis to Whaler Island, and thence to a point where the outer reef rises above high water. Its total length when completed, including the island, will be about 2,300 feet. The breakwater will rise to a height of 6 feet above high water with a thickness

on top of 20 feet and such side slopes as may be assumed under the action of the sea.

At the commencement of the fiscal year operations were in progress upon the construction of the breakwater under contract with A. A. Polhamus. The previous October heavy seas breaking over the structure wrecked the contractor's plant, and an extension of nine months' time was granted in which to complete the contract. At that time the wall had been extended to a point 507 feet beyond the island. An examination made previous to resumption of work showed that the winter storms had damaged the structure more or less from a point 350 feet from the island out to the end, the stones being washed down on the inside slope.

The contractor resumed work in June and completed his contract in August. The amount of rock placed on breakwater in this interval was 3,875.90 tons. With this amount the damaged portion of the breakwater was repaired and a further extension was made to a point 510 feet beyond the island.

Under the appropriation of $40,000 made by the river and harbor act of August 17 last, specifications were issued calling for proposals for continuing operations, and a contract was entered into January 19 last with Patrick O'Neil, the lowest bidder, for rock in place, at $2.23 per long ton.

Operations should have been commenced on the 1st day of May. The contractor was without any suitable outfit, and a delay was caused in his operations. Finally he got started, but met with disaster off Point Sur, whereby his barge, with derricks, engines, etc., was lost. He finally succeeded in getting another outfit and has only recently commenced work. At the close of the fiscal year an insignificant amount of rock had been delivered. The contractor has been notified of the condition of his plant, and steps will be taken to cause him to provide a suitable number of barges with necessary engines, in order that there may be no further delay in the work.

The storms of the past winter knocked over a number of stones near the end of the work, and slightly damaged that portion of the structure between Point San Luis and the island. Under the present contract this latter work will be built up, the wall just beyond the island will be strengthened, and the outer end will be built up and extended. It is expected, with the amount of rock that will be delivered under the present contract, that the breakwater will be extended to a point about 700 feet beyond the island.

The breakwater as far as constructed has added to the security of vessels lying at the anchorage and at the wharf at Port Hartford.

In the interests of economical prosecution of the work, the recommendation made in the last annual report for a suitable appropriation is repeated here.

The total amount appropriated for this improvement is $135,000, as follows:

Act of—	
August 11, 1888	$25,000
September 19, 1890	40,000
July 13, 1892	30,000
August 17, 1894	40,000

The total amount expended, including outstanding liabilities, is $96,550.22.

The amount that can be profitably expended during the fiscal year ending June 30, 1897, is $150,000.

An abstract of bids received is appended.

Money statement.

July 1, 1894, balance unexpended		$11,176.39
Amount appropriated by act of August 17, 1894		40,000.00
		51,176.39
June 30, 1895, amount expended during fiscal year		12,000.23
July 1, 1895, balance unexpended		39,176.16
July 1, 1895, outstanding liabilities	$726.38	
July 1, 1895, amount covered by uncompleted contracts	34,747.12	
		35,473.50
July 1, 1895, balance available		3,702.66
Amount (estimated) required for completion of existing project		433,660.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of bids for building a breakwater at San Luis Obispo Harbor, California, called for by advertisement of November 24, 1894, and opened at 11 a. m. January 4, 1895, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers.

No.	Name of bidder.	Price per ton.
1	John Hackett	$2.37
2	J. M. Taylor	2.93
3	William H. Healy	2.74
4	Patrick O'Neil	2.23
5	Jas. J. Searles	2.42

COMMERCIAL STATISTICS.

[Statistics for both years furnished by the Pacific Coast Railway Company.]

	Year the improvement began (1888).		Year ending December 31, 1894.	
	Incoming.	Outgoing.	Incoming.	Outgoing.
Vessels:				
Steam ..... number	603	603	429	429
Sailing ..... do	34	34	12	12
Total	637	637	441	441
Tonnage	452,149.34	452,149.34	14,858.9	18,006.2
Draft, greatest ..... feet	18	.....	18	18
Merchandise, general ..... tons	8,802	5,669	6,006.6	.....
Coal ..... do	2,985	.....	438.1	.....
Lumber ..... feet	8,884,400	.....	3,142,350	.....
Grain ..... tons	.....	23,305	205.9	7,299.4
Bituminous rock ..... do	.....	15,342	.....	3,528.9
Dairy produce ..... do	.....	.....	3.5	1,284.2
Live stock ..... do	.....	.....	35.6	3,356.9
Miscellaneous freight ..... do	.....	.....	1,884.5	1,021.5
Asphaltum ..... do	.....	.....	.....	924.8
Chrome ore ..... do	.....	.....	.....	590.5

	Tons.
Total amount of freight entered and cleared in 1888	68,425
Total amount of freight entered and cleared in 1894	70,363.4
Increase	1,938.4

No new lines of transportation have been established during the year.

R R 4.

IMPROVEMENT OF WILMINGTON HARBOR, CALIFORNIA.

The present project contemplates gaining a depth of 16 feet at mean low tide at the entrance and in the inner harbor. For this purpose jetties have been constructed from Rattlesnake Island and from Timms Point, on the easterly and westerly sides of the harbor, respectively, and a certain amount of dredging has been done in the inner basin.

Previous to the commencement of the operations in 1871 there was a depth of less than 2 feet at the entrance at mean low tide. Surveys recently made show that there is now at that locality 14.6 feet. The changes in depth take place very slowly, but the surveys made from time to time since the cessation of operations last year show a gradual increase in depth. It is therefore expected that the ultimate depth of 16 feet sought for will ultimately be obtained.

Errors having been discovered in the chart and description of the approved harbor lines, a new chart was made, which was submitted to the Department with description, and received the approval of the Secretary of War May 7 last.

The stonework of the jetties is in good condition, but the timber of the double work of the east jetty is badly worm eaten and should be replaced with stone.

No operations were in progress during the year. The works and property were left in charge of a keeper.

The total amount appropriated for this harbor is $955,000, as follows:

March 3, 1871	$200,000	March 3, 1881	$33,000
June 10, 1872	75,000	August 2, 1882	100,000
March 3, 1873	150,000	July 5, 1884	50,000
March 3, 1875	30,000	August 5, 1886	75,000
June 18, 1878	20,000	August 11, 1888	90,000
March 3, 1879	12,000	September 19, 1890	34,000
June 14, 1880	35,000	July 13, 1892	51,000

The total amount expended to close of fiscal year, including outstanding liabilities, is $951,559.61.

Money statement.

July 1, 1894, balance unexpended	$4,861.32
June 30, 1895, amount expended during fiscal year	1,380.93
July 1, 1895, balance unexpended	3,480.39
July 1, 1895, outstanding liabilities	40.00
July 1, 1895, balance available	3,440.39

IMPROVEMENT OF WILMINGTON HARBOR, CALIFORNIA.

[Printed in Senate Ex. Doc. No. 61, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 7, 1895.

SIR: I have the honor to acknowledge receipt of the resolution of February 6, 1895, of the Senate of the United States directing the Secretary of War—

To transmit to the Senate any report or information which he may have received during the year 1894, and not heretofore made public, with reference to the improvement of Wilmington Harbor, California.

In response to the reference of the above-quoted resolution to this office there is submitted herewith a copy of report of June 8, 1894, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, in which he submits estimates amounting to $392,725 for further improvement of the harbor at Wilmington.

The report of Lieutenant-Colonel Benyaurd is accompanied by two tracings.*

The resolution of the Senate is herewith returned.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., June 8, 1894.

GENERAL: The appropriation of $51,000, made by the river and harbor act of July 13, 1892, filled out the amount estimated for the improvement of Wilmington Harbor, California, with a view of obtaining a depth of 16 feet at the entrance at mean low tide. With the above amount, in addition to a small balance from a former appropriation, work was in progress at the close of the last fiscal year. No additional estimate was at that time presented, for the reason, as stated in the annual report, that it was desirable to ascertain what effect the completion of the work in progress would have upon the deepening of the channel, and if the depth of 16 feet was not realized, surveys to be made would furnish data upon which to base an estimate for continuation of work. At the same time I had also in view the enlargement of the interior basin and the dredging of the inner channel, so that any vessels entering the harbor could lie at the wharves at the lowest stage of the tide. A survey for this latter object was in progress at the date of the last annual report, and is referred to therein. It was intended to present estimates for all work needed in the inner harbor and at the entrance, so that appropriations made in the future could be applied to either locality as the conditions might require.

The work of jetty construction in progress at the beginning of the fiscal year was completed in November. It consisted in raising the east jetty inside Deadmans Island to a height of about 10 feet above mean low tide; in extending this jetty about 425 feet beyond the island, and in raising and further extending the west jetty about 200 feet; this latter stretch was brought to a height of high water only. Since then a survey of the entrance has been made, supplemented by a series of borings to determine the character of the underlying strata at the same locality. Tracing No. 1 herewith shows the condition of the harbor from Deadmans Island to the upper end of Smiths Island, a distance of 10,000 feet; No. 2 shows the depths at the entrance.

From an inspection of tracing No. 1 it will be seen that there is a channel depth of not less than 16 feet at mean low tide from Deadmans Island to the head of the wharves, with lesser depths along the entire easterly wharf front and along the northerly portion of the westerly

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*Omitted. Printed in Senate Ex. Doc. No. 61, Fifty-third Congress, third session.

wharf line. At the entrance a depth of about 14 feet at mean low tide had been obtained at the date of the survey. Advices lately received indicate a deepening at this locality, to what extent can not be definitely stated, but sufficient to warrant the belief that the channel is undergoing some change for the better. On May 15 the ship *Forest Queen*, drawing 18.9 feet, entered the harbor, the stage of the tide being 5.6 feet. Owing to shallow water she was unable to remain at the wharves during the lower stages of tide. This latter circumstance emphasizes the necessity of measures being adopted to increase the depths in the inner harbor to accommodate the class of vessels capable of passing the entrance.

During the years 1890 and 1891 the inner harbor was dredged from the southerly end of the westerly wharf to the upper end of Deadmans Island to a depth of 16 feet at mean low tide over a width on bottom of 300 feet. In former operations under Colonel Mendell a channel had been cut through the reef opposite Deadmans Island to the same depth and width. The recent survey shows that not only has this depth been maintained, but that it has in some instances been increased, indicating that no deterioration of this inner channel has taken place, due to the movement of sand in and out of the harbor during the tidal flow. It is therefore believed that equally good results can be obtained by further dredging. In case, however, of any shoaling, the channel depths can be maintained at moderate expense, for which work, and for general service at the harbor, the Government should have its own dredging machine.

For continuing the improvement it appears desirable to deepen the channel at the entrance; to dredge the inner channel between harbor lines as far as the head of the wharves; to remove and replace with stone portions of the timber work of the east jetty; and ultimately to enlarge the interior basin as the demands of commerce will warrant.

From an original depth of less than 2 feet at mean low water at the entrance, a depth of about 14 feet at same stage has been obtained. The changes in depth due to the works projected for the improvement have been found to take place very slowly, and while it is possible that the ultimate depth of 16 feet originally designed may be obtained without recourse to dredging or further jetty extension, it may be desirable to resort to the former method to expedite the deepening. A comparison of the tracing with others made during the progress of last season's work shows a recession of the outer 16-foot curve near the entrance, which indicates increased depth in the channel on the line of the east jetty. The entrance of the ship before mentioned appears to bear out this view of the changes now in progress. The approach to the entrance is from the southeast, and the deeper channel is around the end of the east jetty. All the study charts show the channel in this position, and from observations made with a number of floats I am of the opinion that this channel is due to the flood currents. On the ebb the floats took directions straight out and about parallel to the general direction of the jetties and toward Point Fermin. If the flood tide could be made to follow the same path the resultant effort would undoubtedly lead to increased depths. This might be accomplished by building out groins from near the end of the west jetty diagonally toward the entrance. For the present, and until we ascertain the effects of other proposed works, I would not, however, recommend that these works be constructed.

The success of the efforts in dredging on the south Atlantic coast, where the movement of sand is far more extensive than obtains at San Pedro, warrants the belief that the entrance could be deepened and main-

tained at moderate expense by like operations. I consider that dredging would be the most economical method of obtaining the increased depth. With a sufficient channel cut through the reef at Deadmans Island, work on the entrance would be carried on as required in connection with the work contemplated for the inner harbor.

The character of the underlying material beyond Deadmans Island limits the depth that I consider we should first attempt to secure at the entrance. A series of borings made on the area between the island and the outer buoy show that below 18 feet there are layers of clay, the overlying stratum being sand capable of being easily moved.

Inside the entrance and opposite Deadmans Island there exists a reef of hard material through which a channel had been cut in former operations. This channel should be widened and deepened, and the ledge projecting from Deadmans Island between ranges 18 and 19 of survey should be removed, so as to provide easier lines for vessels entering or leaving the harbor.

Harbor lines have been established in the inner harbor. Opposite the end of the Southern Pacific Wharf they are 500 feet apart. They follow the wharf fronts on either side, and at the upper end of the San Pedro Lumber Company's property they are about 800 feet apart. This width gradually increases to about 1,500 feet at the head of Smiths Island, the upper limit of the established lines.

Along the front of the Southern Pacific Wharf vessels of 16 feet draft may unload at low water. Along the lumber company's wharves there is less depth, and vessels of that draft are aground at low stages of tide. As the bottom is not hard, the vessels sustain no material damage from grounding. There appears to be a decrease of depth on the middle ground near the head of the wharves, as also along the upper stretch of wharves, as if the middle shoal ground was working down.

On the easterly side of the harbor an extensive shoal place exists along the southerly front of the harbor line. At the Terminal Company's Wharf drawing but 12 or 13 feet of water can unload, and less depth is found at the upper wharves. The ships of the Pacific Coast Steamship Company find difficulty at times in effecting a landing. Until very recently all deep-draft vessels lying in the outer anchorage transferred their entire cargoes to lighters, which were towed to the inner harbor. More recently some have lightered sufficiently to be able to enter and unload at the wharves. Were the interior basin deepened and the wharf fronts dredged there would undoubtedly be an increase in this method of conducting business with the deeper-draft ships, and it would be found that additional wharves would be built along the easterly side of the harbor to accommodate the trade that would be brought there with increased depth. Another difficulty was found with the steamships. While there was sufficient depth of water at the steamship wharf, the space between wharves and the shallow depths prevented the steamships from turning easily preparatory to departure. Were the channel widened and the upper part of the inner harbor dredged this difficulty would be entirely obviated. The steamers would go to the upper part of the basin and turn readily without danger to vessels lying at the wharves.

The character of the material at the reef and in the inner harbor precludes the idea of using the same type of machine for the entire work. In the inner harbor the material is sand and can be easily moved with some form of hydraulic dredger. The ground at the reef would require a different machine, and it would be necessary to resort to blasting operations to first break up the material.

For the purpose of presenting estimates I have taken a channel width at the entrance of 350 feet and a proposed depth of 18 feet. The length of this cut is from the outer 18-foot contour to where the reef commences, about range 19. This would require the removal of 36,000 cubic yards of material. The location as selected is the one that would give the best entrance and exit for vessels in the present condition of the channel. Changes likely to take place before any appropriation is made may require a different location. The channel, once dredged, may partly shoal up again, so the estimates must be considered as only with a view of first attaining an increase of depth by dredging and of ascertaining the feasibility of so maintaining it.

The cut through the reef to a width of 400 feet and depth of 18 feet would require the removal of about 37,000 cubic yards. In former operations the dredging at this point was found to be difficult and expensive.

In the inner harbor the channel 400 feet wide and 18 feet deep may be continued to the wharves, which would require the removal of about 150,000 cubic yards. Along the harbor fronts to the upper end of the wharves the depth should be increased to 20 feet. This would require the removal of about 490,000 cubic yards additional.

Beyond the upper end of the wharves the basin expands. Ultimately the extension of commerce and the interests of the harbor will require the dredging of this portion, but as the period is remote and work not now absolutely required, no account has been taken of the amount thereof.

The timber work of the east jetty, constructed over twenty years ago, is worm-eaten and badly decayed. It should be torn out and replaced with stone. This stone can be placed on the inner slope after the timber is removed. That portion of the jetty can then be brought to the same height and thickness as that just within Deadmans Island. The total amount of stone required for this work is about 8,000 tons.

The estimates for dredging are made on the basis of work heretofore done at the harbor by contract, and it is presumed that future operations may have to be conducted in like manner. If a sufficient appropriation were made to provide the work with a dredging outfit the work on the bar and inner harbor could be done at less cost and the machine would always be on hand for emergencies. The cut through the reef could probably be better done by contract.

The prices heretofore paid for work are about 50 cents per yard for sand and $2.50 for reef material. In the lower part of the inner harbor, where there is but a small face to work upon, the prices might be about the same. In the upper stretch, where the depth of material is quite considerable and the area well protected, the prices should be greatly reduced, especially if a liberal amount be appropriated. The distance of the locality from any dredging center, and the absence of shops for repairs, have always aided in keeping the cost of the work very high.

The estimated cost of the entire work is:

Entrance, 36,000 cubic yards, at 50 cents	$18,000
Reef, 37,000 cubic yards, at $2.50	92,500
Reef to wharves, 150,000 cubic yards, at 40 cents	60,000
Between harbor lines, 490,000 cubic yards, at 30 cents	147,000
Stonework, 8,000 tons, at $3	24,000
	341,500
Contingencies, 15 per cent	51,225
Total	392,725

The above estimate is presented with the recommendation that the improvement of the harbor be continued as indicated, and authority is requested to have same presented in the annual report.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Commercial statistics for the year the improvement began (1871).

	Incoming.	Outgoing.
Vessels:		
Steam	160	160
Sailing	65	65
Total	225	225
Freight, tons	25,313	9,575
Lumber, feet	10,938,336	.....

Statistics of commerce for the year ending December 31, 1894.

[Furnished by the collector of customs at Los Angeles, Cal.]

	Foreign commerce (outer harbor).		Domestic commerce.	
	Incoming.	Outgoing.	Incoming.	Outgoing.
Vessels:				
Steam	1	1	200	201
Sailing	12	11	175	173
Total	13	12	375	374
Tonnage	18,815	17,335	.....	.....
Draft, greatest, feet	26	.....	18½	16
Merchandise, general, tons	.....	.....	5,571	832
Coal, do	29,797	.....	.....	.....
Lumber, feet	517,000	.....	83,123,000	.....
Miscellaneous freight, tons	.....	.....	31,168	4,185

The total amount of revenue collected at the port during the year ending December 31, 1894, was $20,467.45.

The rates upon freights have been reduced since the first expenditure for the improvement of this harbor from $7.50 to 62½ cents per 1,000 feet on lumber and from $5 to 75 cents per ton on general merchandise from the outer harbor.

	Tons.
Total amount of freight entered and cleared in 1871	50,059
Total amount of freight entered and cleared in 1894	187,558
Increase	137,499

No new lines of transportation were established during the year.

R R 5.

IMPROVEMENT OF SAN DIEGO HARBOR, CALIFORNIA.

The approved project for the improvement of San Diego Harbor contemplates the construction of a jetty on Zuninga Shoal at the entrance to the harbor, the maintenance of a channel 24 feet in depth at mean

low tide through the middle ground, and the repair of the dike built across the mouth of San Diego River to divert the waters of that stream into False Bay.

Jetty.—It is intended to construct a jetty about 7,500 feet in length, extending from Coronado Island out on Zuninga Shoal, with a view of gaining 26 feet at mean low tide on the outer bar.

At the commencement of the fiscal year work was being prosecuted under contract with Silas R. Smith. The contractor completed his work July 21 following. Under this contract the jetty was carried to a total length of 2,472 feet, being built up to high water for 1,860 feet, and to low water for 612 feet additional.

Under the appropriation of $50,000 made by the river and harbor act of August 17 last, specifications were issued and proposals were invited for continuing the construction of the jetty. A contract was entered into with Powell & Mitchell, the lowest bidders, for work at the following prices: Trestle, $5 per linear foot; brush mattresses in place, at $1.90 per cubic yard; stone, $2.25 per long ton. Work under this contract was commenced in April, but owing to the rejection of the entire number of piles first delivered it was not until June that work was in active progress. At the close of the fiscal year the trestle had been advanced a further distance of 882 feet; the jetty wall was further completed to high water for a length of 224 feet, and a foundation course laid for 248 feet additional. The quantities of material used in the construction were 714 cubic yards of brush mattresses and 2,173 tons of stone.

During the coming season work will be continued to the extent of the available funds. The jetty will be built up to high water for a length of several hundred feet; a spur about 300 feet long will be built on the channel side, and the shore revetment will be built up and extended.

No effects of jetty extension have as yet been noticed upon the bar depth, and none are expected until the work shall have been extended some considerable distance seaward.

The jetty work executed under the previous contract remained in good condition, having withstood well the winter storms. A settlement of about 2 feet took place in the shore revetment for a length of about 400 feet. Some local scour took place beyond the end of the jetty. When work was suspended at the completion of the Smith contract, a depth of 5 to 6 feet at mean low water existed at and immediately beyond the end of the jetty, and at 300 yards farther seaward depths of 2 to 3 feet were found. On resuming work this year a depth of about 18 feet was found at the first mentioned locality and about 8 feet at the other. As the jetty is extended seaward it is expected that increased scour will occur, calling for increased quantities of material for the construction, and thereby necessarily increasing the cost of construction beyond that estimated for in the original project. The details of the work carried on during the past year are given in the report of Mr. F. C. Turner, assistant engineer, herewith.

Middle ground.—The depth at this locality remains about the same as previously reported, viz, 16½ feet at mean low tide. No work was done during the past year, and none is contemplated until the jetty work shall have been extended seaward a sufficient length to cut off the movement of sand over Zuninga Shoal, and thereby permit dredging of this shoal channel with some prospect of maintaining it in a permanent condition.

Dike.—This work was completed in 1876, and since then small amounts have been expended in keeping it in repair.

In January last one of the highest floods known occurred in San Diego River. The northerly end of the dike for a length of about 100 feet was overtopped for a short time, and there was some danger of the river breaking through. Residents of the vicinity whose property was threatened piled up some sand bags on the top of the levee and secured it from danger. At the lower or southerly end of the levee the river is reported to have come within 6 inches of the top. The berm, with its stone protection at the foot of the outer slope, along the northerly end of the levee, was excavated by the flood, and will need repair. This work will be done before the winter season.

An abstract of bids received for jetty construction is appended.

An appropriation of $200,000 is asked for the fiscal year ending June 30, 1897.

The total amount appropriated for San Diego Harbor since 1875 is $242,500, as follows:

Act of—	
March 3, 1875	$80,000
March 3, 1879	1,000
August 11, 1888	1,000
September 19, 1890	60,500
July 13, 1892	50,000
August 17, 1894	50,000

The total amount expended, including outstanding liabilities, is $202,577.31.

This work is in the collection district of San Diego.

Money statement.

July 1, 1894, balance unexpended		$32,921.65
Amount appropriated by act of August 17, 1894		50,000.00
		82,921.65
June 30, 1895, amount expended during fiscal year		33,060.95
July 1, 1895, balance unexpended		49,860.70
July 1, 1895, outstanding liabilities	$9,938.01	
July 1, 1895, amount covered by uncompleted contracts	35,404.99	
		45,343.00
July 1, 1895, balance available		4,517.70
Amount (estimated) required for completion of existing project		234,400.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

Abstract of bids for continuing operations on jetty at San Diego Harbor, California, called for by advertisement of November 30, 1894, and opened at 11 a. m., January 16, 1895, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers.

No.	Name of bidder.	Spur and shore revetment.										
		250 feet double-track trestle.		640 feet decked single-track trestle.		160 feet undecked single track trestle.		1,100 cubic yards brush mattresses.		7,300 tons of stone.		Total cost of spur and revetment.
		Per linear foot.	Total.	Per linear foot.	Total.	Per linear foot.	Total.	Per cubic yard.	Total.	Per ton.	Total.	
1	William H. Healey ..	$6.50	$1,625.00	$5.75	$3,680	$5.75	$920	$2.20	$2,420	$2.44	$17,812	$26,457.00
2	Waldo S. Waterman	Three thousand dollars.						2.60	2,860	2.99	21,827	27,687.00
		7.00	1,750.00	4.40	2,816	5.00	800	2.55	2,805	2.40	17,520	25,691.00
3	Powell & Mitchell,..	Three thousand dollars.						1.90	2,090	2.25	16,425	21,515.00
4	James J. Searles.....	6.35	1,587.50	5.20	3,328	5.75	920	2.75	3,025	2.20	16,060	24,920.50

Abstract of bids for continuing operations on jetty at San Diego Harbor, California, called for by advertisement of November 30, 1894, and opened at 11 a. m., January 16, 1895, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers.

No.	Name of bidder.	Balance available for building main jetty.	Main jetty.							
			Per linear foot of double-track trestle.	1¼ cubic yards of brush mattresses.		15 tons of stone.		Total per linear foot of main jetty.	Number of feet of main jetty that can be built under bid.
				Per cubic yard.	Total per linear foot.	Per ton.	Total per linear foot.		
1	William H. Healey	$18,543.00	$6.50	$2.20	$3.85	$2.44	$36.60	$46.95	394
2	Waldo S. Waterman	17,313.00	5.00	2.60	4.55	2.99	44.85	54.40	318
		19,309.00	7.00	2.55	4.46	2.40	36.00	47.46¼	406
3	Powell & Mitchell	23,485.00	5.00	1.90	3.32½	2.25	33.75	42.07½	558
4	James J. Searles	20,079.50	6.35	2.75	4.81½	2.20	33.00	44.16¼	454

REPORT OF MR. F. C. TURNER, ASSISTANT ENGINEER.

SAN DIEGO, CAL., *June 30, 1895.*

COLONEL: Work on the San Diego Jetty, under the contract with S. R. Smith, was ended July 21, 1894. Under the contract that jetty was carried to a total length of 2,472 feet, being built up to high water for 1,860 feet, and to about low water for 612. In this work the following quantities of material were used, viz: 2,462½ linear feet of double-track railway trestle, 4,723.2 cubic yards of brush mattresses, and 32,134 gross tons of stone.

Work under contract with Powell & Mitchell began in April, 1895, but, owing to the rejection of the piles first delivered by reason of the bark stripping under the hammer, it was not actively prosecuted until June 3. By the end of the month, and fiscal year, the trestle work had been advanced 882.9 feet, which is all that will be built under this contract; the jetty wall completed to high water, 224 feet farther, and the foundation course 248 feet. The quantities of material used were 714.18 cubic yards of brush mattresses and 2,173.19 tons of stone.

The work to be done under this contract is to extend the jetty about 880 feet, to build a spur 300 feet long from near the end of the main jetty out toward the channel, and to extend the shore revetment about 200 feet and raise it where it has settled.

The methods of work are the same as those adopted last year, except for the spur and revetment work, where lighters will be used. The stone is of the kind first delivered by Mr. Smith under the last contract—a hard, heavy so-called porphyry from the Sweetwater Valley. The brush has come from the San Luis Rey River near Oceanside, but hereafter will be cut on the Sweetwater and Tia Juana rivers in order to save railroad haul. It is a good quality of willow, the same as was used last year.

Owing to the shortness of the piles they could be driven only for from 9 to 11 feet for much of the distance. As they were of good size, and as the mattresses and rock soon increase their stability, and as they seemed amply strong, the average set under a 2,400 hammer falling 10 feet being only about 1 inch, the contractor was allowed to make up the deficiency of penetration by putting in an extra pile, so that only 20 bents were driven with the specified three piles each.

The piles in the old work, which were driven from eleven to thirteen months ago, were chopped into without any marks of the teredo being seen, and heavy cars of rock have been run safely over them this month. Yesterday, however, it was reported to me that a piece of scantling, apparently from the grillage of the foundation mattresses, jarred up, perhaps, by falling rock, had been found on the beach and was badly bored.

The work has withstood the winter excellently, having made little apparent settlement and there being few gaps where the smaller stones had been knocked off the top. The revetment wall, however, for about 400 feet nearest the channel, sank about 2 feet, apparently from the undermining of the beach in front. The steel rails have rusted considerably, scales 0.1 inch thick coming off.

No change has been reported in the depth of the channel across the bar at the entrance of the harbor, nor was any expected until the jetty had been extended farther out. But the local changes on the shoal in the vicinity of the jetty have been very marked. A bank of sand has formed along the west or inside of the jetty from sand driven through or over the rock wall by the waves from the outside, a most

gratifying result, as it tends to strengthen the wall and render it tighter. The beach has built out farther at the root of the jetty, so that the low-water mark is out nearly to the end of the approach curve. This shore accretion extends eastward about 2,000 feet; but about one-half mile farther east, and extending for some miles below the hotel, there has been a recession of the shore line, caused by the winter storms. It may be proper to state that this cutting can in no way be attributed to the construction of the jetty, but is merely one of the mutations ocean beaches are subject to. The shoals in general have been flattened, the crests having been lowered from 6 inches to 1 foot over large areas. The outer patch of breakers has shifted still more to the eastward, away from the channel, and the inner one has moved in the same direction, nearer to the jetty, and both have diminished in area.

As was expected, a channel formed during the winter across the end of the jetty. The flood tide is predominant so far, swinging in around the end from the east and from along the shore, as at San Pedro, but the ebb tide is getting stronger as we push out. Most of the scour, I think, is done during rough weather, the waves stirring up the sand for the current to carry in suspension. The strongest current I have yet noted was about 2 feet per second, a flood tide across the jetty. When the last pile was driven in May, 1894, the depths in front were from 5 to 6 feet, and at 300 yards out, where the trestle now is, only about 2½ to 3 feet. At the time of the survey at the end of the contract, July and August, there was a hole in front with a maximum depth of 7.8 feet, shoaling up to about 5 feet 300 yards out. On beginning work this spring it was found that a channel had formed with a depth of 18 feet at the end of the jetty and of 8 feet 300 yards out. The trestle was built in water from 19 to 8½ feet deep, and the mattresses will probably be a half foot deeper. Over this same line the map of the survey of 1887, on which the project was based, shows depths of 1 and 2 feet, in places the sand being bare at extreme low tide. This advance scour is bound to occur to increasing extent as the jetty is built out and more waterway obstructed, forcing a larger volume of tide around the end. These channels must be filled up with rock and brush, and greatly increase the estimated quantities of material required for the completion of the work. With rapid work a low foundation course could be laid a long distance ahead before building up the wall and much of this scour prevented. With small intermittent contracts the teredo renders it inexpedient to run out long lines of piling, so this can not be done. The magnitude of the work of harbor improvement of the United States presumably renders it inexpedient, also, to finish up these works in single contracts, but to do so would greatly reduce the cost.

Heretofore the aim has been to keep the cross section of the work as light as possible, with the idea that the sand would fill up around it and strengthen it, while the position so far back behind the protection of Point Loma and behind the shoal in front greatly reduced the force of the waves before they struck it. With every foot of advance the exposure becomes greater and will require a stronger section, so that this matter of scour becomes a matter of serious moment from the standpoint of cost.

Very respectfully,

F. C. TURNER,
Assistant Engineer.

Lieut. Col. W. H. H. BENYAURD,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Commercial statistics for the year the improvement began.

	Vessels.	Freight.
	Number.	*Tons.*
Entered	201	24,809
Cleared	195	11,647

The vessels, including 109 steamers, had an aggregate tonnage of 122,311 tons.

Commercial statistics for the year ending December 31, 1894.

[Furnished by Mr. John C. Fisher, collector.]

	Incoming.	Outgoing.
Vessels:		
Steam	221	218
Sailing	108	103
Total	329	321
Tonnage	203, 208	197, 769
Draft, greatest, feet	24	24
Merchandise, general, tons	34, 927	3, 762
Coal, do	86, 594	.....
Lumber, feet	17, 758, 000	228, 000
Grain, tons	.....	8, 675
Merchandise,* general, foreign, valued at	$442, 400	$195, 564

* No record is kept of the amount in tons exported or imported.

Amount of revenue collected at the port during the year ending December 31, 1894, $76,667.

	Tons.
Total amount of freight entered and cleared in 1876	36, 456
Total amount of freight entered and cleared in 1894, exclusive of foreign merchandise	158, 904
Increase	122, 448

No new lines of transportation were established during the year.

R R 6.

IMPROVEMENT OF COLORADO AND GILA RIVERS AT YUMA, ARIZONA.

The project for this improvement contemplated the construction of a levee, in length about 3,400 feet, along the easterly boundary of Yuma, so as to protect that town from the floods of the Gila River.

The levee was completed in January, 1893. It is now in good condition and no further work is contemplated.

The total amount appropriated for this improvment was $10,000, and the total amount expended was $9,781.75.

Money statement.

July 1, 1894, balance unexpended	$359.91
June 30, 1895, amount expended during fiscal year	141.66
July 1, 1895, balance unexpended	218.25

R R 7.

PRELIMINARY EXAMINATION OF HARBOR OF EL MORO, CALIFORNIA.

[Printed in House Ex. Doc. No. 198, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 8, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated December 29, 1894, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, giving results of a preliminary examination of harbor at

El Moro, Cal., made in accordance with the directions of the river and harbor act of August 17, 1894.

It is the opinion of Colonel Benyaurd, in which I concur, that El Moro Harbor is worthy of improvement by the General Government.

A survey of the locality it is estimated will cost $200.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., December 29, 1894.

GENERAL: I have the honor to present the following report upon the preliminary examination of harbor of El Moro, provided for in the river and harbor act of August 17 last.

The harbor is situated about the middle of the coast boundary of San Luis Obispo County, and distant southward from the Bay of San Francisco about 200 miles, and 20 miles to the northward of Port Harford, where a breakwater is now in course of construction by the General Government.

The basin which forms the harbor is about four miles in length, with its axis lying nearly north and south, and is separated from the ocean by a strip of sand beach. The width of the estuary will average somewhat less than a mile, giving a high-water area of about 2,250 acres. At the northerly end of the harbor two channels—to the northward and southward of "The Morro," a huge granitic rock lying directly in the entrance—lead to the interior basin. These two channels are subject to considerable variations; when one is at its maximum width and depth the other is at its minimum, but generally the northerly channel has been found to be the better under the ordinary conditions prevailing. The southerly channel opens up to the southward, and is exposed to the southerly winter gales that prevail, and is, therefore, usually better in summer than in winter. In like manner the sand spit on the north side of the northerly channel changes with the season; in the spring of the year when the northwest winds are strong it crowds down and extends toward Pillar Rock, narrowing the channel. As the winds moderate in summer the channel widens with the good weather until in September it is about twice as wide as in April and May.

A survey of the harbor designated as Estero Bay was made under the direction of Col. G. H. Mendell, Corps of Engineers, in 1873. It was found that vessels drawing 7 feet could enter at low water by one channel or the other. The average rise of tide was about 4 feet, so that vessels drawing 11 feet could enter at that stage. Once over the bar a good channel of 12 feet at mean low tide could be carried to the wharf, about a mile from the rock, and beyond that point extending for nearly 2 miles a channel of 8 feet was found. My recent examination showed the conditions existing in the inner basin have undergone some change. The tidal basin appears to be shoaling, but to what extent can not be stated. Some of the causes are probably due to the wash from the shores of the bay, from sand blown into the basin, from breaks that have occurred in the strip of sand beach, and in addi-

tion there are several small creeks that empty into the bay, whose bottom lands, once covered with brush and sod, are now cultivated, and every flood brings soil into the bay.

For the past four years material for the breakwater at San Luis Obispo Harbor has been obtained from the inner side of Morro Rock, near the junction of the two channels. All the vessels were taken through the northerly channel, and at times as great a draft as 12 feet could be carried to the quarry wharf. There seems to be no reason why steam vessels drawing 10 or 11 feet might not now enter at ordinary high water. There is a rock in the northerly channel lying close to Morro Rock which is somewhat of an obstruction, but it can be avoided by steam vessels. Sailing vessels would find it difficult to beat into the harbor, owing to the narrow channel. At the wharf a change is found to have occurred, and where on the old survey depths of 12 feet and over at mean low tide were found, vessels would now only be able to unload at high water. It is possible, however, with moderate expense, to change the location of this wharf so as to always have sufficient depth along its front line.

The variation in the width and depth of the two channels—that is, when one deteriorates the other becomes better—suggested the nature of the improvement that should be made, which was to close one channel permanently. With this view, as the result of the former survey, it was recommended that the south channel be closed by a dike extending from Morro Rock to the shore opposite. * * * No work was ever done, as no appropriation was made for the purpose.

As regards the commerce, Moro is a little village containing two stores and a few dwelling houses. In addition to the ordinary supplies needed for the immediate neighborhood, lumber is the principal import, three or four lumber schooners arriving and departing each year. A few years ago grain and dairy produce found an outlet at Moro, but now nearly all the shipments of this character are made from Cayucos, a coast landing 6 miles to the northward, which point is reached by the steamers of the Pacific Coast Steamship Company. At the southerly end of the bay the town of El Moro has been laid out, under the auspices of the El Moro Improvement Company, but no great advance has been made in the settlement of the place.

The land adjacent to and bordering the bay is rich and adapted to agricultural and grazing purposes, but is held in quite large tracts. It is represented that this will soon be divided into small farms, which will invite immigration, and with the cultivation that will ensue the commercial necessities of El Moro Harbor will be greatly increased. The same condition of affairs existed at the time of the former survey, and the same argument for the improvement was then advanced, but in the twenty years that have elapsed there appears to have been but little change in the surroundings. Since the date of the former survey the General Government has undertaken the improvement of San Luis Obispo Harbor, 20 miles to the southward; railroad lines have been projected into the neighboring territory, and a landing for steamers has been made at Cayucos, 6 miles to the northward. The territory that would now mainly rely upon El Moro for shipment has, therefore, a limited area. There is no doubt that were this territory divided into small farms, settlement would be induced and a considerable amount of grain and dairy products could be raised for shipment. Considering the small amount of money that has been estimated for the work, it would be good policy in that event for the Government to undertake the improvement, but I consider that the settlement of the country and

production of articles for shipment should to some extent precede the appropriation for the work.

Simply considering the commercial necessities alone I do not think the improvement of the harbor of El Moro should be undertaken, but there is another feature to be considered, and that is the improvement of the channel way in connection with the work now being undertaken by the Government for the harbor of San Luis Obispo. Examinations of the country around Port Harford (San Luis Obispo Harbor) have failed to find any rock of suitable quality or in sufficient quantity to fill any of the contracts for the work. It is only at Moro that the necessary quantity can be found, and it is believed that all contracts in future must be filled from this place. Morro Rock rises to a height of 580 feet, is about 1,800 by 1,700 feet at the base, and contains many million cubic yards of material. The main difficulty the contractors have to deal with is getting in and out of Moro Bay at favorable stages of tide, and considerable loss of time is experienced in the undertaking. Once outside with the loaded barges, transportation to Port Harford is a simple matter. Necessarily, this factor is considered in making up the proposals, and it is believed that a reduction in contract price could be obtained were the difficulties of navigation removed or rendered easier.

As many thousand tons of rock will be yet required to complete the breakwater, extending the period of construction over a number of years, it might be deemed advisable for the Government to undertake the improvement for this purpose alone. It might not be necessary to carry the dike closing the south channel to the full height as originally projected, but this could be determined after a reconsideration of the project. At the same time the work could be done in an economical manner in connection with the Port Harford construction, the work not requiring any more of a quarry outfit than that needed for that work alone. With the execution of this work the development of the adjacent country might be hastened and the benefits that would be derived more than compensate the Government for the outlay. With this view and to the extent of the work indicated, I consider El Moro Harbor worthy of improvement by the General Government. The cost of a survey of the locality will not exceed $200.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

R R 8.

PRELIMINARY EXAMINATION OF SAN RAFAEL CREEK, CALIFORNIA.

[Printed in House Ex. Doc. No. 126, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 13, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated December 5, 1894, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, giving results of preliminary examination of San Rafael Creek, California, made to comply with requirements of the river and harbor act of August 17, 1894.

Colonel Benyaurd reports that, in his opinion, San Rafael Creek is not worthy of improvement by the Government, and in this opinion I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., December 5, 1894.

GENERAL: I have the honor to present the following report on the preliminary examination of San Rafael Creek, as provided for in the river and harbor act of August 17, 1894.

San Rafael Creek empties into the bay of San Francisco, about midway between points San Quentin and San Pedro, on the westerly side of the bay and distant from the ferry landings at San Francisco about 15 miles. Navigation is possible only at a high stage of tide, as at low tide the creek itself and the shoal outside are bare. The vessels that engage in the trade are flat-bottomed sailing vessels, averaging probably 50 tons burden.

An examination of this creek was made in conformity with the river and harbor act of September 19, 1890, and the report thereon will be found in that of the Chief of Engineers, United States Army, for 1891, page 2963.

Since the date of that examination parties interested in adjacent lands have excavated a canal from the lower landing to a point 3,000 feet nearer the town. This canal was about 52 feet on top, with side slopes of one on one, and was excavated to a depth of 1 foot below low tide. The objects of this improvement were—

First. To permit navigation up to the town by the class of vessels above mentioned, instead of landing at the old embarcadero, three-fourths of a mile below.

Second. To facilitate the flood discharge of a fresh-water creek passing through the town, and which periodically overflowed the low-lying portion.

Third. To reclaim the marsh land on either side of the canal.

The latter two features are probably the most important objects sought for by the improvement.

From the present head of navigation as made by the canal to the shore of the bay the distance is about 3 miles. The width in the upper reaches of the creek is from 40 to 60 feet, increasing slightly as the mouth is reached. The banks are low and marshy and mostly covered at high spring tides. Beyond the mouth there is an extensive mud flat, through which at low tide there is only the indication of a channel, and a depth of only 6 feet is gained at a distance of about 1½ miles from shore. When navigation is possible, there is a better channel in the creek proper than through the flat.

Any permanent improvement of the creek would necessitate the widening and deepening of the creek and the dredging and maintenance not only of that channel, but also of a channel through the flat. This improvement would necessitate the formation of a tidal basin inside and the construction of training walls outside, as without these auxiliary

works the forces that now operate to cause the shoaling would soon obliterate any channel dredged through the flat.

As to the commerce, there is nothing exported from San Rafael, nor is it likely that any great change for the better in this respect would result were the improvement made. The imports consist of lumber, coal, sand, lime, and like bulky freight. There is apparently no great variation in amount from that stated in the former report. The improvement of the creek would necessarily benefit this commerce, and would likewise be of great advantage to the adjacent marsh lands, but the works that would need to be constructed to attain the result would be extensive and costly, and, in my opinion, incommensurate with the advantages to commerce that would be derived by their construction. For this reason I am of the opinion that San Rafael Creek is not worthy of improvement by the Government.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

R R 9.

PRELIMINARY EXAMINATION OF SUISUN CREEK, CALIFORNIA, WITH A VIEW TO IMPROVEMENT OF CHANNEL.

[Printed in House Ex. Doc. No. 205, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 11, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 5, 1895, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, upon the preliminary examination of Suisun Creek, California, "with a view to improvement of channel," made to comply with the provisions of the river and harbor act of August 17, 1894.

It is the opinion of Colonel Benyaurd, in which I concur, that Suisun Creek is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., January 5, 1895.

GENERAL: I have the honor to inclose herewith a report upon the preliminary examination of Suisun Creek, California, with a view to the improvement of channel, made under my direction by Lieut. Charles L. Potter, Corps of Engineers, in pursuance of requirements of the river and harbor act of August 17, 1894.

Suisun Creek is a tidal inlet from Suisun Bay, and is in length about 18 miles. It is navigable by a class of small flat-bottomed sailing ves-

sels not exceeding probably 80 tons burden, which carry coal, lumber, and like bulky freight for local consumption at Suisun, and by which hay and wheat are exported on return trips. The amount of the commerce could not be ascertained, though repeated efforts were made to obtain it from those who appeared interested in the improvement.

The class of vessels engaged in the trade draw about 2 feet light, and from 5 to 6 feet when fully loaded. From the report of Lieutenant Potter it will be seen that a depth of 6 feet at half tide can be carried from the bay to the reach in front of the wharves, and except at a small bar about 2 miles below town the same depth can be had at low tide. It appears that this depth is sufficient for the class of vessels and for the commerce of Suisun, and therefore no further improvement is thought desirable to be undertaken at the present time. I concur in the opinion of Lieutenant Potter that Suisun Creek is not worthy of improvement by the General Government.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF LIEUT. CHAS. L. POTTER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., December 22, 1894.

SIR: I have the honor to submit the following report of the preliminary examination of Suisun Creek, made in compliance with your letter of December 5, 1894.

I visited the town of Suisun and interviewed the parties most interested in the improvement, and the representative men of the place, including two members of the town council.

The principal commerce of the place is: Exports—wheat, hay, and fruit; and imports—coal and lumber.

No information was to be obtained as to the amounts of these shipped annually. Your letter to the postmaster had been given to the town council, and they had neglected to attend to the matter. They promised to get up the statistics at once and furnish the information in time for your report.

The wheat and hay are shipped by sailing scows drawing from 3 to 5 feet when loaded. The majority of the fruit is shipped directly east by rail. The coal and lumber are brought in by sailing scows.

The creek is about 18 miles long from the town to the mouth, and does not extend above the town, being entirely tidal water. I went about 11 miles down the creek to a point below the highest point reached by the Coast Survey charts, and these charts give a better idea of the creek below than I could have obtained.

From this point to the town I took a sounding every minute, and found a depth of from 3 to 6 fathoms up to a point about 2 miles from town, where a bar is found on which there was only 1½ fathoms. After passing this bar the sounding showed 2 fathoms up to the last reach along which the wharves lie, and in this reach there was only 1 fathom. All of these soundings were made in the last hour of the flood and the first hour of the ebb tide, or practically at high water.

The Coast Survey charts show a depth of over 4 fathoms at high tide from the point where I made the first sounding to the bay, except on the bar at the mouth, where there is a depth of only 2½ fathoms at high tide. The creek is wide enough to permit scows to beat up it against the wind.

The rise of ordinary tides is about 6 feet, and hence it will be seen that a depth of 6 feet at half tide can be had from the bay to the reach in front of the wharves; and, except across this small bar mentioned above, the same depth can be had at low tide. A depth of 6 feet will accommodate all scows and flat-bottomed steamers.

It appears that the scows are able to handle all commerce at present going by the creek, and without much inconvenience, taking advantage of high tide to get to the wharves and away again, and the largest of them to cross this small bar.

The people of the town have two reasons for wishing the improvement:

1. To allow coasting schooners to come directly in with coal and lumber, and—

2. To have steamers making regular trips, claiming, as a result, that a large part of the fruit shipment would then go that way to the decided benefit of the growers.

The answer to the first proposition can not well be made until statistics are furnished showing the amount of coal and lumber imported annually.

In answer to the second, it seems that there have already been three attempts made to run steamers on the creek, and in each case the railroad has either bought out the companies or have put down the rates from Vacaville and places above to such a point that the steamers could not pay expenses.

The material in front of the wharves is a soft mud, and all parties acquainted with the creek in the past say that when steamers did run there was no difficulty, as they stirred up the mud and it was carried away, leaving a depth sufficient for their purposes.

There are three landings on the water front, the lowest one being used for the shipment of hay and grain, the middle one for the same purpose and also as a general landing for steamers and other craft, while the upper one is the landing for a lumber yard only. The two lower ones are only about 100 yards apart, while the upper one is probably 200 yards above the middle one. Any improvement above the middle landing would affect only the lumber yard.

The owner of the middle landing, the one most generally used, says the creek is good enough for all purposes at the present time.

Unless the statistics, when furnished, should show some good reason why the improvement should be made, I do not consider Suisun Creek worthy of improvement by the General Government at the present time.

Very respectfully, your obedient servant,

CHAS. L. POTTER,
First Lieut. of Engineers.

Lieut. Col. W. H. H. BENYAURD,
Corps of Engineers.

R R 10.

PRELIMINARY EXAMINATION OF NAPA RIVER, CALIFORNIA, BETWEEN NORTH AND SOUTH VALLEJO, WITH A VIEW OF IMPROVEMENT AND CONFINEMENT OF CURRENT TO KEEP CHANNEL OPEN.

[Printed in House Ex. Doc. No. 127, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 13, 1894.

SIR: I have the honor to submit the accompanying copy of report dated December 5, 1894, by Lieut. Col. W. H. H. Benyaurd, Corps of Engineers, giving results of a preliminary examination of Napa River, California, between North and South Vallejo, "with a view of improvement and confinement of current to keep channel open," made in accordance with provisions of the river and harbor act of August 17, 1894.

Colonel Benyaurd reports that he is of opinion that Napa River at this point, or Mare Island Strait, as it is properly called, is worthy of improvement by the General Government. I concur in the opinion expressed by Colonel Benyaurd.

The cost of a survey and incidental expenses will not exceed $400.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF LIEUT. COL. W. H. H. BENYAURD, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., December 5, 1894.

GENERAL: I have the honor to present the following report upon the preliminary examination of "Napa River between North and South Vallejo, with a view of improvement and confinement of current to keep channel open," as provided for in the river and harbor act of August 17 last.

The stretch of river in question is known as Mare Island Strait, and connects Napa Creek with the Straits of Karquinez, which latter affords communication with the Bay of San Francisco. In length it is about 3½ miles. The westerly bank of the strait is occupied exclusively by the Mare Island navy establishment, while on the easterly side are located the towns of North Vallejo, Vallejo, and South Vallejo.

Approaching Mare Island Strait from Karquinez Straits, a good depth of water obtains for all purposes of navigation. At the entrance the width between high-water shore lines is above 1,250 feet, with a channel depth of fully 5 fathoms. The width gradually increases as we approach Vallejo, again narrows between the Vallejo landing and that of the navy-yard, and increases again at the northerly limit of the strait opposite North Vallejo. At the wide parts extensive mud flats occur, which are bare at low water, and we find considerable reduction in channel depths. These mud flats have greatly increased in height in late years and have encroached upon the low-water channel way, but as no survey has been made of the locality since 1876, except one at the upper limit of the navy-yard, no comparison can be made that will give the extent of the changes that have occurred.

There is a good depth and width of channel for all navigation except through a stretch extending from Vallejo to South Vallejo, in length about four-fifths of a mile. About in the middle of this stretch, opposite the dividing line between the two towns and directly in mid-channel, there is a rocky shoal known as Commission Rock, which is bare at low water. There is good water on the westerly or navy-yard side of it, where 3½ fathoms can be carried. The channel on the easterly side has been shoaling for years, and there is a long tail of rock stretching to the southeast. Within the 3-fathom curve the length of this shoal is about one-fourth of a mile, with a width across at the location of the beacon of about 550 feet. The ruling depth through the stretch in question is about 3½ fathoms at mean low tide. In my opinion, this depth is not as great as should be desired for the purposes of a naval establishment like that at Mare Island, not only for the larger ships of the Navy, but likewise for vessels of supply. It was stated to me at the time of the examination that a ship loaded with coal intended for the navy-yard was compelled to discharge a portion of her cargo at San Francisco, as the draft was too great to approach the yard.

Considering the above facts in the case, and that the importance of the naval establishment at Mare Island demands a channel free from all obstructions and of sufficient depth for all classes of ships, I am of the opinion that Napa River at this point, or Mare Island Strait, as it is properly called, is worthy of improvement by the General Government. The cost of a survey and incidental expenses will not exceed $400.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

R R 11.

ESTABLISHMENT OF HARBOR LINES AT WILMINGTON HARBOR, CALIFORNIA.

SAN FRANCISCO, CAL., *April 30, 1895.*

GENERAL: Under date of July 18, 1891, a Board of Engineer Officers, consisting of Col. G. H. Mendell, Maj. W. H. Heuer, and myself, rendered a report recommending for adoption certain pierhead and bulkhead lines at Wilmington Harbor, California. On July 8, 1892, the Board submitted a supplementary report recommending the extension of the lines on the easterly side of the harbor to cover the front of the property of the Los Angeles Terminal Railway Company on Rattlesnake Island. The lines as laid out received the approval of the Secretary of War.

The map, as submitted, and upon which the lines were laid out, was from a survey made for the purpose by Lieutenant Meyler. Upon laying out the lines at first it was found that the map did not agree with others on file in the office and which had always been accepted as correct. Lieutenant Meyler went over his work again and reported his survey as practically correct.

Surveys of a more recent date, made under my direction, and others by the Terminal Railway Company in connection with the wharf front, confirm the incorrectness of Lieutenant Meyler's survey in certain portions of the upper basin; the width across is somewhat greater than as determined by him. The construction of the wharves had not progressed very far when the errors were discovered, so that the terminal company was directed to keep the wharf front on what would be considered correct harbor lines when duly established.

I have caused a new map to be made, and have laid down upon it certain lines which are recommended for new harbor lines in place of those already accepted and approved. Additional lines have also been laid out in front of Smiths Island. This is done from the fact that the San Pedro Lumber Company, owning the water front of the island, has applied to the county supervisors for a wharf franchise. There is not sufficient depth of water along this front for the purposes of the company, and there is no prospect of any work being done in the near future to increase it unless the company does it; still as a franchise will be granted, it has been deemed better to extend the harbor lines to cover the property in question. The following is a complete description of the proposed harbor lines for Wilmington Harbor, California:

WESTERLY SIDE OF HARBOR.

PIERHEAD LINE.

In front of Smiths Island.—Beginning at a point in the center of the main track of the Southern Pacific Railroad Company and on the top edge of the abutment of the railroad trestle at the northerly side of Smiths Island; thence to a point 50 feet therefrom and on a line at right angles to said track at the point of beginning; thence to a point distant 290 feet from center of said track and on a line at right angles to said track at a point 200 feet southerly from the point of beginning; thence parallel to the said track to a point on a line at right angles to the railroad track at a point 16 feet south of the top edge of the abutment of the trestle at the southerly end of Smiths Island; thence to the point 16 feet south of the top edge of the abutment of the trestle and in the center of the track.

From the line last mentioned a gap will be left for the channel between Smiths Island and the mainland on which is the town of San Pedro.

In front of town of San Pedro.—Beginning at a point in the center of the railroad main track and on the top edge of the abutment of the trestle at the northern side of the town of San Pedro; thence to a point 50 feet from the center of said track on a line at right angles to direction of the track; thence to the northeasterly corner of the wharf of the San Pedro Lumber Company as at present constructed, which corner is distant 258 feet from the center of the main track of the Southern Pacific Railroad Company; thence along the face of said wharf 703 feet to a point 193.6 feet from the center of the main track of the Southern Pacific Railroad Company; thence to a point on the prolongation of the southerly boundary of Third street in the town of San Pedro and distant 693 feet from the easterly side of Beacon street; thence to a point 552 feet easterly of the easterly line of Beacon street and 70 feet northerly of the northerly side of Fifth street; thence along the face of the wharf of the Southern Pacific Railroad Company in a curve substantially parallel to the single work of the east jetty of the harbor to the southeasterly corner of said wharf; thence in a straight line to the west jetty, through a point which is on the prolongation of the northerly line of Seventeenth street, and distant 1,950 feet from the easterly line of Beacon street prolonged.

BULKHEAD LINE.

Front of Smiths Island.—The bulkhead line begins at the point of beginning of the pierhead line and follows the course of the latter until it reaches a point 200 feet distant from the center of the railroad track; thence it runs parallel to said track until the pierhead line is again intersected, whence it follows the course of the latter to the end.

Bulkhead line in front of town of San Pedro.—There is a bulkhead already constructed to protect the tracks of the Southern Pacific Company. The line of the face of that portion of the bulkhead from its upper or northerly point opposite Smiths Island at the railroad trestle abutment to the point where it joins the southerly end of the present wharf construction is adopted as a part of the bulkhead line herein recommended. From the point last mentioned the line is continued parallel to the pierhead line until it intersects the west jetty.

DISTANCES OF BULKHEAD FROM CENTER OF TRACK OF SOUTHERN PACIFIC RAILROAD.

At point where center line of track crosses following street lines, distances measured perpendicular to track:

	Feet.
North side Ninth street	20.00
South side Eighth street	9.00
South side Seventh street	10.00
South side Sixth street	10.24
South side Fifth street	8.80
South side Fourth street	13.46
South side Third street	14.97
North side Seventh street	10.07
North side Sixth street	10.13

EASTERN SIDE OF HARBOR.

PIERHEAD LINE.

Beginning at a point on the prolongation of the southerly line of Eleventh street in the town of San Pedro, and distant 360 feet from the single work of the east jetty; thence to a point on the prolongation

of the southerly side of Ninth street and 500 feet distant from the pierhead line established for the western side of the harbor; thence in a curve substantially parallel to the line of the single work of the east jetty to a point on the prolongation of the northerly side of Fourth street; thence to a point on a line normal to the single work at its northerly end and distant 284 feet from said single work; thence to the southwesterly corner of the wharf of the Crescent Coal Company, as at present constructed; thence to a point on a line normal to the direction of the track of the Southern Pacific Railroad Company passing through the northeasterly corner of the wharf of the San Pedro Lumber Company, and distant 805 feet from said corner; thence to a point on a line normal to the direction of the track of the Southern Pacific Railroad Company passing through the top edge of the trestle abutment of the northern side of Smiths Island, and distant 1,500 feet from the center of said track.

BULKHEAD LINE.

Beginning at a point on the prolongation of the southerly line of Eleventh street in the town of San Pedro, and distant 30 feet from the single work of the east jetty; thence parallel to the line of said single work to a point on a line normal to said single work passing through its northerly end; thence on a line normal to the single work to a point distant 90 feet from the pierhead line; thence parallel to the pierhead line to the line through the northeasterly corner of the wharf of the San Pedro Lumber Company drawn normal to the track of the Southern Pacific Railroad Company, excepting that where this bulkhead line intersects the line of high water the latter line will be followed as the bulkhead line until a point is reached distant 90 feet from the pierhead line; thence from the point opposite the corner of the San Pedro Lumber Company's Wharf above mentioned to a point on a line normal to the track of the Southern Pacific Railroad Company, passing through the top edge of the abutment of the trestle on the northerly side of Smiths Island and distant 1,650 feet from the center of said track.

The lines hereinbefore described and the points above mentioned are shown and located on the accompanying map,* which is to be considered with and which forms a part of this description. With the exception of the additional lines in front of Smiths Island, the lines as above described are substantially those originally adopted by the Board, the difference being that they are now delineated on a correct map.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Lieut. Col., Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Corps of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
May 6, 1895.

Respectfully submitted to the Secretary of War, recommended for approval.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

NOTE.—The lines described in the above report and shown on the map accompanying were approved by the Secretary of War under date of May 7, 1895, the approval being indicated on the map.

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* Omitted.

APPENDIX S S.

IMPROVEMENT OF SAN JOAQUIN AND SACRAMENTO RIVERS AND TRIBUTARIES, AND OF RIVERS AND HARBORS IN CALIFORNIA NORTH OF SAN FRANCISCO.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. San Joaquin River, California.
2. Mokelumne River, California.
3. Sacramento and Feather rivers, California.
4. Petaluma Creek, California.
5. Humboldt Harbor and Bay, California.

EXAMINATIONS AND SURVEYS.

6. Feather River, California, above Marysville.
7. Georgiana River, California.
8. Mendocino Harbor, California.
9. American River, California.
10. Old River Branch of San Joaquin River, California.
11. Crescent City Harbor, California.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., July 3, 1895.

GENERAL: I have the honor to transmit herewith my annual reports for the fiscal year ending June 30, 1895.

* * * * * * *

Very respectfully, your obedient servant,

W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

S S 1.

IMPROVEMENT OF SAN JOAQUIN RIVER, CALIFORNIA.

Description.—The San Joaquin River, from Firebaugh to its mouth, flows in a general northwesterly direction and empties into Suisun Bay near the mouth of the Sacramento. During its high-water stage the

river is navigable for light-draft boats to Hills Ferry, nearly 100 miles above Stockton, and sometimes even to Firebaugh, nearly 100 miles farther. During the periods of high water, however, there is but little freight available for boats, while during low-water periods there is not enough water in the upper river for navigation purposes. The lower river below Stockton is practically an estuary.

Original condition.—Before improvement the low-water channel to Stockton was only 6 feet in depth, while the upper river above Stockton was navigable but for few months in the year, during high-water stage, and then only for boats drawing 2 feet of water or less.

Work prior to June 30, 1894.—The project for the improvement of this river was adopted in 1877 and slightly modified in 1881 and 1888. It has for its object to secure and maintain by dredging a channel 9 feet deep at low water and 100 feet wide through the tidal portions of the river and Stockton Slough to Stockton, and a channel 4 feet deep at low water and 100 feet wide to Millers Warehouse, in Mormon Slough; the temporary improvement of the low-water channel by dredging, scraping, the removal of snags, and the construction of small wing dams and the closure or partial closure of Paradise Cut and Laird Slough.

Up to 1887 all the dredging on this river was done by contract and the price varied from 45 to 15 cents per cubic yard. In 1887 a dredge was built by the Government, and since that time the cost has averaged less than 10 cents per cubic yard. Dredging has been carried on each year during the low stage of the river, and the river has also been straightened by three cut-offs near Devils Elbow, one at Head Reach, a double cut-off in the narrows below Stockton, and a double cut-off at Twenty-one Mile Slough. All the cut-offs made have been self-maintaining.

In December, 1888, a dam for the partial closure of Paradise Cut was completed. During the excessive floods of 1891 it was injured beyond repair, and was rebuilt in the fall of 1891. It was again repaired in 1892.

A dam was also constructed across Laird Slough during August and September, 1891. Owing to damage by flood it was partially rebuilt in the fall of 1892.

Amount expended and results obtained to June 30, 1894.—The amount expended on the San Joaquin River up to June 30, 1894, was $321,260.44. The constant work of improvement had given and maintained a low-water channel of 9 feet in depth to Stockton, and rendered steamboating to that city comparatively easy and safe all the year round.

The upper river had been improved by the partial closure of Paradise Cut and Laird Slough, but the annual time of navigation was not materially lengthened.

APPROPRIATIONS.

August 14, 1876	$20,000	August 11, 1888	$25,000
June 14, 1880	20,000	September 19, 1890	75,000
March 3, 1881	40,000	July 13, 1892	65,000
August 2, 1882	40,000	August 17, 1894	50,000
July 5, 1884	20,000		
August 5, 1886	18,750	Total	373,750

Report of operations for the past fiscal year.—At the end of August, 1894, the low-water dam at Laird Slough had become so weakened that it was in danger of being flanked at the next high water and required immediate attention. Bids were therefore invited to repair it, and the following received:

Darby Laydon, San Francisco, Cal.:

1,320 linear feet of round piles, at 35 cents per foot	$462.00
4,800 linear feet sheet piles at $0.1527 per foot	732.96
12,000 wales and braces, at $0.023⅓ per foot	277.33
225 yards of excavation, at $1.30 per yard	292.50
400 tons of stone, at $4.52½ per ton	1,810.00
200 cords of brush, at $2.80 per cord	560.00
Driving 40 piles, at $5 per pile	200.00
Total	4,334.79

Cotton Bros. & Co., San Francisco, Cal.:

1,320 linear feet of round piles, at 20 cents per foot	264.00
4,800 linear feet of sheet piles, at 30 cents per foot	1,440.00
12,000 feet wales and braces, at $0.024 per foot	288.00
225 yards of excavation, at 40 cents per yard	90.00
400 tons of stone, at $2.80 per ton	1,120.00
200 cords of brush, at $3.60 per cord	720.00
Driving 40 piles, at $6 per pile	240.00
Total	4,162.00

W. H. Healy, San Francisco, Cal.:

1,320 linear feet of round piles, at 20 cents per foot	264.00
4,800 linear feet of sheet piles, at 25 cents per foot	1,200.00
12,000 feet wales and braces, at $0.018 per foot	216.00
225 yards of excavation, at 25 cents per yard	56.25
400 tons of stone, at $3.50 per ton	1,400.00
200 cords of brush, at $3.75 per cord	750.00
Driving 40 piles, at $4.00 per pile	160.00
Total	4,046.25

B. McMahon & Son, San Francisco, Cal.:

1,320 linear feet of round piles, at 29 cents per foot	382.80
4,800 linear feet of sheet piles, at 21 cents per foot	1,008.00
12,000 feet of wales and braces, at $0.035 per foot	396.00
225 yards of excavation, at 50 cents per yard	112.50
400 tons of stone, at $4.80 per ton	1,920.00
200 cords of brush, at $4.35 per cord	870.00
Driving 40 piles, at $4.80 per pile	192.00
Total	4,881.30

Angus McKinnon, Stockton, Cal.:

1,320 linear feet of round piles, at 27 cents per foot	356.40
4,800 linear feet of sheet piling, at 20 cents per foot	960.00
12,000 feet of wales and braces, at $0.027 per foot	324.00
225 yards of excavation, at 50 cents per yard	112.50
400 tons of stone, at $3.50 per ton	1,400.00
200 cords of brush, at $1.70 per cord	340.00
Driving 40 piles, at $4.50 per pile	180.00
Total	3,672.90

Contract was entered into with Angus McKinnon, of Stockton, for the work, which was commenced October 22, 1894, and completed December 1, 1894.

The east bank, where much erosion had occurred, was protected by a bulkhead 184.6 feet long, measured around the top; the structure consisted of Wakefield sheet piling, each made of three 2-inch planks, driven to a depth of 8 to 15 feet below low-water level. These sheet piles were supported by wales of 10 by 12 inch pine, fastened to round piles driven 6 feet apart on three sides of a square. This structure forms an abutment for the east or right hand end of the dam.

The old boxes of sand and some of the fascines were removed to secure a firm foundation for the new work; around, between, and for

20 feet in front of the piles in the old dam, loose brush was placed and weighted with large pieces of granite. The slopes of the banks were also protected with brush and stone. The dam as repaired is 6 feet above low-water level.

The following items of material were used in repairs: 1,259 linear feet of piles (round); 4,624 linear feet of sheet piles; 10,330 feet of wales and braces; 457 tons of stone; 318 cords of brush. The total cost of the work, including inspection and engineering expenses, was $4,251.10.

The channel in Stockton Slough having again shoaled, the dredge was set to work there on October 10, 1894, and continued to dredge until January 15, 1895, when the river rose to such an extent as to render further work unnecessary. During this time cuts were made aggregating 9,645 feet in length, 50 feet in width, and to a depth of 9 to 10 feet below low water. In doing this 100,986 cubic yards of material were dredged and pumped on shore. The cost of the work was $7,637.51, or 7.5 cents per cubic yard.

After the dredge was laid up for the season the machinery was found to be in such condition as to require extensive repairs, and the boilers unfit for further service. Bids were invited and opened April 25, 1895. The following were received:

For new boilers—	
Wm. J. Brady, San Francisco, Cal	$3,475.00
T. J. Moynihan, San Francisco, Cal	2,495.00
J. A. Cunningham, Sacramento, Cal.:	
With Otis brand of steel	2,697.00
With other brand of steel	2,631.00
Wm. Dick, San Francisco, Cal	3,200.00
P. F. Dundon, San Francisco, Cal	3,095.00
Risdon Iron and Locomotive Works, San Francisco, Cal	3,417.00
For repairs to machinery:	
T. J. Moynihan, San Francisco, Cal	1,707.95
Atlas Iron Works, San Francisco, Cal	1,820.00
E. F. Cadle & Sons, Stockton, Cal	1,696.00
P. F. Dundon, San Francisco, Cal	2,629.00
W. E. Tretheway, Stockton, Cal	1,275.00
F. Loftis, San Francisco, Cal	2,495.00
Risdon Iron and Locomotive Works, San Francisco, Cal	2,073.00

Contract was entered into with T. J. Moynihan, of San Francisco, for the new boilers, and with W. E. Tretheway, of Stockton, for repairing the machinery. The work was in progress, but had not been completed at the end of the fiscal year.

The hull of the dredge also required repairing, as many of the timbers had become rotten. It was therefore hauled out on the ways at Alameda Point and put in thorough order.

Early in October, 1894, a small party was sent to Hills Ferry, the head of navigation on the San Joaquin River, and proceeded from there downstream, removing such snags and other obstructions as impeded navigation. The party worked from small skiffs, the river being too shallow to permit of the use of a large boat, and on foot, using small charges of giant powder to assist them in removing the snags. During the low-water period, while the snagging was being done, the skiffs used by the working party frequently got aground in the channel.

By the middle of December the work was completed as far down as the San Joaquin Bridge, when the river rose to such an extent as to stop further work. During the time work was in operation, 125 miles of the San Joaquin River and 18 miles of the Tuolumme were cleared of snags and other obstructions. There were removed from the San

Joaquin River 368 limbs of trees, 70 trees, and 556 snags, to do which 586 blasts were fired, using 572 pounds of giant powder.

From the Tuolumne 41 limbs of trees, 28 trees, and 152 snags were removed, to do which 160 blasts were fired, using 101 pounds of giant powder. The total cost of the work, which has been of considerable benefit to navigation, was $1,108.95.

On May 4, 1895, a small party was again sent to the upper San Joaquin River to remove some snags which had formed and obstructed navigation. The work was completed by May 14, 1895, leaving a channel free from snags from the San Joaquin Bridge to the head of navigation. This work cost $219.50.

At the San Joaquin Bridge, which crosses the river about 20 miles above Stockton, several shoals had formed obstructing the passage of boats. To remove these shoals three wing dams were built. Commencing 900 feet above the bridge, a dam was run out 100 feet into the stream; 255 feet lower downstream another dam, 113 feet long, was placed, and a third was built 255 feet still lower down. This latter was 122 feet long. The dams were arranged to concentrate the current into the left hand draw opening of the bridge, and endeavor to scour a good channel there.

The dams were built of brush, sunk with bags of sand, and weighted with boxes filled with sand. The brush was held in place by 4 by 4 inch pine piles, from 12 to 20 feet in length. They were driven 4 feet apart each way, and to a penetration of 5 to 8 feet. The rows of piles were held together with 1 by 6 inch boards nailed to each pile. The height of the dam is about 2 feet above low water. An old roadway, which led to the ferry maintained here before the bridge was built, was also removed, and a depth of 2 feet at lowest stage of the river secured. The total cost of the work, including engineering and inspection expenses, was $1,328.57.

In October, 1894, the dam at Paradise Cut required some repairs to make it secure against the floods of the winter. A small party was put to work strengthening it, and it was made secure at a cost of $517.

Amount expended and results obtained during the past fiscal year.—The amount expended on the San Joaquin River during the past fiscal year was $20,985.97, making the total amount thus far expended $342,246.41. A low-water channel of 9 feet in depth has been maintained to Stockton, and there has been no interruption to steamboat traffic to that city. In the upper river, above Stockton, the snagging has benefited navigation.

Future operations.—Dredging is necessary each year to keep Stockton Slough in a navigable condition; in fact, without it steamboats would soon be unable to reach Stockton. When funds permit, the cut-offs at Head Reach and Twenty-one Mile Slough can be increased in width and depth with advantage to navigation. Some work may also be necessary on the wing dams near San Joaquin Bridge, and in the upper river more or less snagging will be advantageous.

With any future appropriations, depending on the amount and the requirements of commerce, it is proposed to continue work in the following order, unless Congress should otherwise direct:

1. Dredging to maintain 9 feet depth to Stockton	$40,000
2. Increasing cut-off at Head Reach, in width, depth, or both	37,750
3. Increasing cut-off at Twenty-one Mile Slough, in width, depth, or both	20,000
4. Snagging, etc., in upper river	10,000
5. Strengthening wing dams at San Joaquin Bridge	2,000
Total	109,750

All the above amounts can be advantageously expended in one fiscal year.

Remarks.—The trade between San Francisco and Stockton is large and important, there being two regular lines of steamers running steamboats every week day between the two cities. The commerce of the river is now carried on 12 steamers of from 98 to 880 tons, averaging 550 tons, and drawing 1.5 to 7 feet of water, on 14 barges of from 160 to 660 tons, averaging 300 tons, and on several scow schooners.

While the improvements made have been of the greatest benefit to navigation, it is doubtful if they have caused any reduction in the rates of freight or insurance. It is almost certain, however, that if they were discontinued there would soon be a material increase.

A rod record showing the stage of the river at San Joaquin Bridge from June 1, 1894, to May 31, 1895, is inclosed.

Money statement.

July 1, 1894, balance unexpended	$2,489.56
Amount appropriated by act of August 17, 1894	50,000.00
	52,489.56
June 30, 1895, amount expended during fiscal year	20,985.97
July 1, 1895, balance unexpended	31,503.59
July 1, 1895, amount covered by uncompleted contracts	3,770.00
July 1, 1895, balance available	27,733.59
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1897	109,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

STATISTICS OF TRADE.

The following statement of the freight carried on the San Joaquin River by the boats and barges of the California Navigation and Improvement Company was furnished by Captain Corcoran, the manager of the company:

Down freight:			
Grain from Stockton	tons	42,713	
Grain from points above	do	5,827	
Grain from points on Old River	do	8,496	
Mill stuffs from Stockton	do	79,073	
Produce	do	15,890	
Miscellaneous freight	do	10,000	
			161,999
Up freight:			
Lumber to Stockton	do	42,045	
Miscellaneous freight to Stockton	do	30,200	
Miscellaneous freight to up-river points	do	3,900	
			76,145
Total freight carried			238,144
Passengers			100,178

The following statement of freight carried by the Union Transportation Company between San Francisco and Stockton during the past year was furnished by Capt. J. H. Phillips, the secretary of the company:

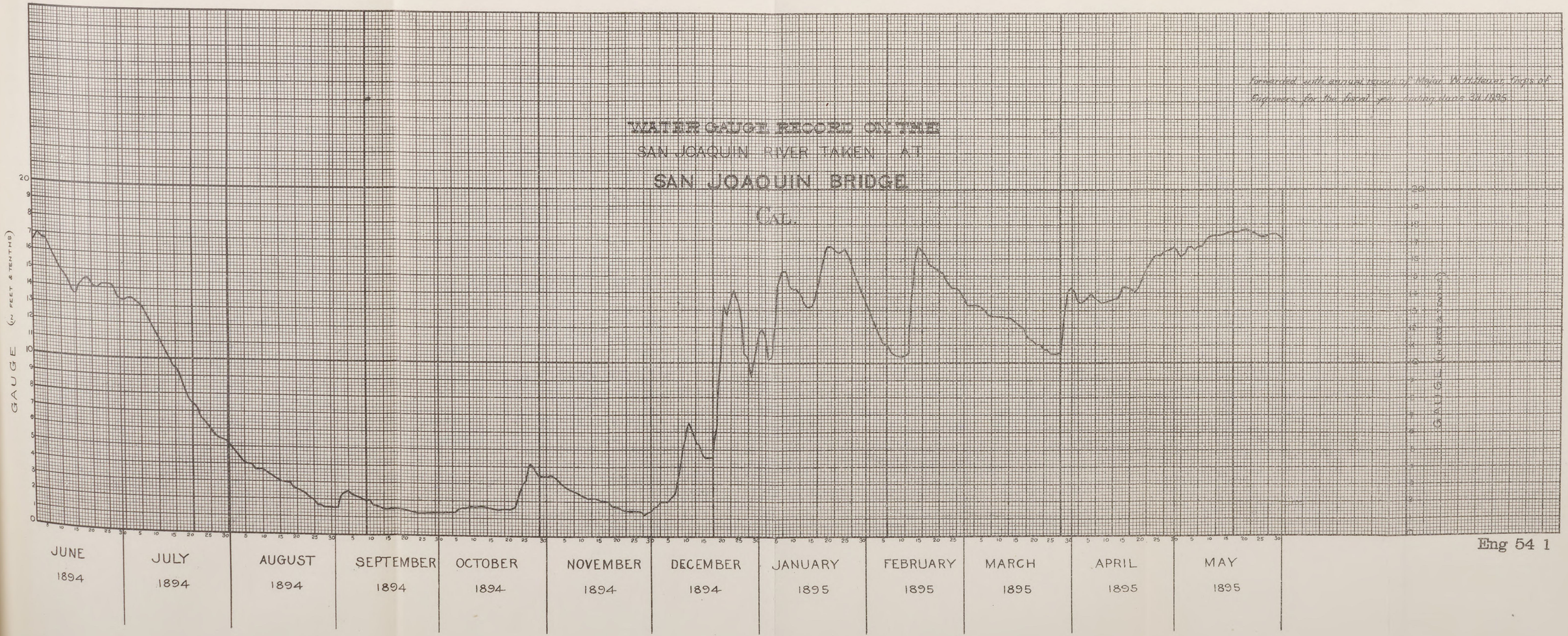
Miscellaneous freight	tons	52,460

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* Indeterminate.

Forwarded with annual report of Major W. H. Heuer, Corps of Engineers, for the fiscal year ending June 30, 1895.

WATER GAUGE RECORD ON THE SAN JOAQUIN RIVER TAKEN AT SAN JOAQUIN BRIDGE CAL.



Eng 54 1

The following freight was carried on the river by the steamer *Ellen*, Capt. A. F. Williams, owner:

Hay	tons..	1,896
Lumber	do...	96
Cordwood	do...	3,115
Total		5,107

This makes the total tonnage for this river reported by the carriers 295,651 tons. This does not include the freight carried on numerous scow schooners, of which it is impossible to collect statistics.

S S 2.

IMPROVEMENT OF THE MOKELUMNE RIVER, CALIFORNIA.

Description.—The Mokelumne River is a tributary of the San Joaquin, and enters it about 20 miles above the mouth of the latter. In the lower part of its course it is subject to tidal influence, and is always navigable to New Hope Landing. Although in seasons of high water boats go a few miles farther upstream, New Hope Landing is practically the head of navigation. At this point the channel separates into the north and south forks, which unite again about 4 miles before reaching the San Joaquin. The length of the north fork is 9 miles, and of the south fork 14 miles.

Original condition.—Before improvement navigation on this river was dangerous and difficult on account of numerous snags and overhanging trees.

Work prior to June 30, 1894.—A project for the improvement of this river was made in 1884, having for its object the removal of the trees and snags obstructing navigation. Both forks of the river were cleaned out in 1884, 1885, 1886, 1887, and 1888, rendering steamboating to the head of navigation easy and safe. This completed the project as outlined, and since then no work of improvement has been done on the river.

Amount expended and results obtained to June 30, 1894.—The amount expended on this river up to June 30, 1894, was $12,480.70. Since 1888 snags have re-formed, trees regrown, and the channel again requires clearing out, although navigation has not been interrupted. Another obstruction is a point of land jutting out into the channel opposite New Hope Landing. This landing, at the junction of the two forks, is the most important one on the river. The south fork, which is bridged at this point, is hardly navigable for 1½ miles below. The river proper and the north fork make a junction which is nearly a right angle. The point of land referred to, being a tongue between the river and the north fork, is constantly extending into the fork, increasing the curvature of the bend, and in consequence of the current making it difficult for a boat to get to the landing at New Hope.

APPROPRIATIONS.

July 5, 1884	$8,500
August 5, 1886	2,500
August 11, 1888	2,000
July 13, 1892	2,500
August 17, 1894	2,500
Total	18,000

Amount expended and results obtained during the past fiscal year.—The amount expended during the past fiscal year was $43.50. No further

results were obtained, as no work was done on the river during the fiscal year.

The appropriation act of 1894 contains the following language:

> Improving Mokelumne River, California: Continuing improvement, two thousand five hundred dollars, including snagging as far as county bridge at Thornton's, on said river: *Provided,* That no part of said sum shall be used until the drainage canal cut by private parties near New Hope Landing shall have been closed.

This canal has been closed in due course. An examination was then made of that portion of the river above New Hope Landing, extending up the river as far as Thornton's Bridge, with a view to ascertaining what snags were in the way. It was found that the banks above New Hope Landing were lined with trees, which contracted the channel, some 15 to 20 feet that in places was only about 50 feet wide. With the exception of a few trees, however, none of the growth was at all dangerous to navigation, as it could be easily brushed aside by very light-draft vessels. There were found also 3 snags which require removal.

The obstacle now remaining is the tongue of land on the right bank of the river opposite New Hope Landing. This piece of land, about one-fourth of an acre in area, is owned by two brothers, one of whom has offered to grant to the Government the right to cut it away free of expense. Efforts have been made to get him and his brother to execute the necessary deed granting the permission, but up to the present time they have not done so. As soon as they do the work can be done.

Future operations.—There is available for work on this river $5,475.80, which is sufficient to cut off the point of land above referred to and remove such snags and overhanging trees as obstruct navigation. Private parties have lately done a large quantity of dredging in this river for the purpose of levee building, and it is now in fairly good navigable condition. The present available funds are therefore amply sufficient for the next two years.

Remarks.—The commerce of this river is carried on one stern-wheel steamer, the *Constance* (385 tons, draft light 2.5 feet, loaded 6 feet), which makes one to three round trips per week, and the steamer *Ellen* (91 tons), which makes occasional trips into the river. Several scow schooners also make trips into this river, but it is impossible to obtain any accurate statement of their business. The freight carried by the steamers on this river during the year amounted to 41,799 tons, and as the rate of freight by the river is $1 per ton less than by railway from competing points, there is a saving to the community of over $41,000, and although it can not be asserted that the improvements have caused any material reduction in the rates of freight or insurance, it is certain that they have been of great benefit.

Money statement.

July 1, 1894, balance unexpended	$3,019.30
Amount appropriated by act of August 17, 1894	2,500.00
	5,519.30
June 30, 1895, amount expended during fiscal year	43.50
July 1, 1895, balance unexpended	5,475.80
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1897	(†)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

* Indeterminate. † Sufficient on hand.

STATISTICS OF TRADE.

Freight carried by the California Transportation Company.

[Furnished by Captain Anderson, the secretary of the company.]

Steamer *Constance:*		
Miscellaneous freight	tons..	41,457
Passengers		3,300
Steamer *Ellen*, Capt. A. F. Williams, owner:		
Potatoes	tons..	342

This makes the total freight carried on the river during the year 41,799 tons.

S S 3.

IMPROVEMENT OF THE SACRAMENTO AND FEATHER RIVERS, CALIFORNIA.

Description.—The Sacramento River is a navigable stream as far as Red Bluff, about 275 miles above its mouth. For twenty years, however, after the railroads were put in operation, boats did not find it commercially profitable to go above McIntosh Landing, about 45 miles below. In 1893 they went as far as Tehama, and in 1894 again began running regularly as far as Red Bluff.

The Feather River is a tributary of the Sacramento, entering it about 16 miles above the city of Sacramento. It is a navigable stream for about 30 miles above its mouth to its junction with the Yuba River at the town of Marysville.

Original condition.—Before improvement was begun navigation was difficult on account of numerous bad snags, shoals, shallow bars, and rapids, but the exorbitant rates that could be charged for freight and passage, owing to there being no competition, made steamboating profitable.

Work prior to June 30, 1894.—In 1874 a project was made and approved for the improvement of both rivers. It had for its object the temporary improvement of the low-water channels by removing snags, scraping bars, and building wing dams. Work has been continuous on this project ever since whenever funds permitted.

The river and harbor act of September, 1890, provided for a Board of Engineers to examine and report on the Sacramento and Feather rivers with a view to their future improvement. In their report (see Annual Report of the Chief of Engineers, 1891; p. 2990) the following appropriations were recommended:

1. A specific yearly appropriation of $25,000 for snagging, building wing dams, etc., above the city of Sacramento.
2. A specific appropriation of $275,000 for removal of obstructions in the lower Sacramento River, and $25,000 for the closure of Jacob Slough.
3. A specific appropriation of $300,000 for the treatment of the Yuba River near and above Marysville.
4. A specific annual appropriation of $20,000 for improving the navigable channel of the Feather River.

The views of this Board were approved, and, in consequence, in 1892 the project was modified and increased to include the closure of Jacob Slough, a crevasse above the city of Sacramento, the maintenance of navigation on the Feather River by means of wing dams to remove shoals, and the treatment of the Yuba River near and above Marysville.

The snagging in the upper Sacramento River had up to 1892 been carried as far upstream as McIntosh Landing, but in that year was continued to Tehama, and in 1893 as far as Red Bluff. A railroad bridge, built without a draw, crosses the river at that point.

In 1893 Jacob Slough was closed, and a new mouth made for the Yuba River near Marysville, promoting a more harmonious confluence between it and the Feather.

Amount expended and results obtained to June 30, 1894.—The amount expended on the Sacramento and Feather rivers to June 30, 1894, was $578,314.92. The results have been of the greatest benefit to navigation; without the snagging, in fact, navigation on the upper river would be impossible. Freight and insurance rates are greatly reduced in consequence of the improvements.

APPROPRIATIONS.

March 3, 1875	$15,000	August 11, 1888	$20,000
June 18, 1878	15,000	September 19, 1890	30,000
March 3, 1879	20,000	July 13, 1892	150,000
June 14, 1880	45,000	August 17, 1894	115,000
March 3, 1881	60,000		
August 2, 1882	250,000	Total	760,000
July 5, 1884	40,000		

Report of operations during the past fiscal year.—The U. S. snag boat *Seizer* had started out a few days before the close of the last fiscal year, and on July 1, 1894, was working in the upper river, near Colusa. Work was continued, and all snags that interfered with steamboating as far as Red Bluff, the head of navigation, were removed. Wing dams, for the purpose of concentrating the currents and removing shoals, were built at Vina Bar, Dayton Bar, Chards, Blethen Island, Moons Shoal, and Sam Soule Bar. By the use of the small steam pile-driver which had been fitted to the snag boat they were quickly and substantially constructed. The work on the upper river was completed and the snag boat returned to Sacramento on October 27, 1894. During the work on the upper river 684 snags were removed, 231 blasts were fired, using 1,746 pounds of giant powder, and 1,853 miles run. There were also constructed 1,055 linear feet of wing dams, containing 465 piles and 1,245 cubic yards of brush.

During October, 1894, while the river was at a very low stage, a very bad bar formed in the draw of the bridge at Sacramento, and for a short time completely stopped navigation. A pile driver was procured, and, starting from a point on the west side about 200 feet above the bridge, a double row of piles were driven out into the stream for a distance of 190 feet, terminating directly above the center of the west pier of the bridge. The row had a deflection of 25° downstream from a right angle to the bank. The rows were 5 feet apart with 6 feet between bents, the tops of the piles being 5.5 feet above low water. A 3-pile dolphin was erected at the outer end of the dam. There were used 57 piles, aggregating 1,800 linear feet in length. When the snag boat returned to Sacramento on October 27, she was immediately put to work cutting brush and filling in between the two rows of piles with brush weighted with sand bags. In this way a substantial and effective wing dam was constructed which answered the desired purpose of removing the shoal. After this dam was completed the snag boat proceeded to the lower river and removed 6 snags and 10 leaning trees near Walnut Grove Ferry. To do this 18 blasts were fired, using 97 pounds of giant powder, and 81 miles run. The boat then returned to Sacramento and

was finally laid up November 13, 1894. The total cost of the snagging, which includes the cost of the wing dam built at the draw of the Sacramento Bridge, was $15,982.34.

After the snag boat was laid up for the season, an examination of the boiler showed that it would be unsafe to attempt to use it any longer. Specifications were accordingly prepared and bids invited for furnishing a new one. Bids were opened March 7, 1895, the following being received:

T. J. Moynihan, San Francisco, Cal.:	
Delivered in San Francisco	$2,640
Delivered in Sacramento	3,260
Fulton Engineering and Shipbuilding Works, San Francisco, Cal.:	
Delivered in San Francisco	3,125
Delivered in Sacramento	3,199
P. F. Dundon, San Francisco, Cal.:	
Delivered in San Francisco	2,643
Delivered in Sacramento	2,783
Risdon Iron and Locomotive Works, San Francisco, Cal.:	
Delivered in San Francisco	2,076
Delivered in Sacramento	2,194
J. A. Cunningham, Sacramento, Cal.:	
Delivered in San Francisco	3,130
Delivered in Sacramento	2,980

Contract was accordingly entered into with the Risdon Iron and Locomotive Works to put the boiler in the boat at Sacramento. The work had not been completed at the end of the fiscal year.

The surveys made at the sites of the shoals which had existed in the lower river, below Sacramento, showed that the only one that remained was at Heacock, about 8 miles below Sacramento, the others having so far improved that they were no longer in any way impediments to navigation. Specifications were accordingly prepared and bids invited for building wing dams at Heacock Shoals. They were opened August 20, 1894, the following being received:

Darby Laydon, San Francisco, Cal.:	
11,000 linear feet of piles, at 16½ cents	$1,815.00
1,000 tons of rock, at $1.93	1,930.00
Driving and capping 350 piles, at $2.70	945.00
2,500 cubic yards brush in mattresses, at 87½ cents	2,187.50
2,500 cubic yards loose brush, at 73 cents	1,825.00
Total	8,702.50
James A. McMahon, San Francisco, Cal.:	
11,000 linear feet of piles, at 18½ cents	2,035.00
1,000 tons of rock, at $2.34	2,340.00
Driving and capping 350 piles, at $4	1,400.00
2,500 cubic yards brush in mattresses, at 90 cents	2,250.00
2,500 cubic yards loose brush, at 60 cents	1,500.00
Total	9,525.00
Cotton Bros. & Co., Oakland, Cal.:	
11,000 linear feet of piles, at 16 cents	1,760.00
1,000 tons of rock, at $2.60	2,600.00
Driving and capping 350 piles, at $3.60	1,260.00
2,500 cubic yards brush in mattresses, at $1.28	3,200.00
2,500 cubic yards loose brush, at 68 cents	1,700.00
Total	10,520.00

Healy, Tibbitts & Co., San Francisco, Cal.:	
11,000 linear feet of piles, at 15 cents	$1,650.00
1,000 tons of rock, at $2.40	2,400.00
Driving and capping 350 piles, at $3.50	1,225.00
2,500 cubic yards brush in mattresses, at 70 cents	1,750.00
2,500 cubic yards loose brush, at 50 cents	1,250.00
Total	8,275.00
James M. Taylor, San Francisco, Cal.:	
11,000 linear feet of piles, at 15 cents	1,650.00
1,000 tons of rock, at $2.60	2,600.00
Driving and capping 350 piles, at $2.40	840.00
2,500 cubic yards brush in mattresses, at 95 cents	2,375.00
2,500 cubic yards loose brush, at 95 cents	2,375.00
Total	9,840.00
California Construction Company, San Francisco, Cal.: *	
11,000 linear feet of piles, at 13.2 cents	1,452.00
1,000 tons of rock, at $2.10	2,100.00
Driving and capping 350 piles, at 23.4 cents	81.90
2,500 cubic yards brush in mattresses, at 99 cents	2,475.00
2,500 cubic yards loose brush, at 90 cents	2,250.00
Total	8,358.90
Thomas Thomson, San Francisco, Cal.:	
11,000 linear feet of piles, at 15 cents	1,650.00
1,000 tons of rock, at $2.96	2,960.00
Driving and capping 350 piles, at $6	2,100.00
2,500 cubic yards brush in mattresses, at 85 cents	2,125.00
2,500 cubic yards loose brush, at 60 cents	1,500.00
Total	10,335.00
Angus McKinnon, Stockton, Cal.:	
11,000 linear feet of piles, at 21 cents	2,310.00
1,000 tons of rock, at $2.65	2,650.00
Driving and capping 350 piles, at $3.50	1,225.00
2,500 cubic yards brush in mattresses, at $1.15	2,875.00
2,500 cubic yards loose brush, at 90 cents	2,250.00
Total	11,310.00
William Elliott, sr., Marysville, Cal.:	
11,000 linear feet of piles, at 18 cents	1,980.00
1,000 tons of rock, at $3.35	3,350.00
Driving and capping 350 piles, at $3.80	1,330.00
2,500 cubic yards brush in mattresses, at $1	2,500.00
2,500 cubic yards loose brush, at 85 cents	2,125.00
Total	11,285.00
James Simpson, Eureka, Cal.:	
11,000 linear feet of piles, at 19 cents	2,090.00
1,000 tons of rock, at $2.50	2,500.00
Driving and capping 350 piles, at $3.75	1,312.50
2,500 cubic yards brush in mattresses, at $1.20	3,000.00
2,500 cubic yards loose brush, at 90 cents	2,250.00
Total	11,152.50

Contract was accordingly entered into with Healy, Tibbitts & Co. to build the dam. They commenced work on September 1, and completed it November 19, 1894. The following is the material used in the dams:

*After the bids were opened this bidder stated that the price he bid for driving and capping piles was intended as 23.4 cents per foot of pile.

277 piles driven, aggregating 8,709 feet in length; 3,028 cubic yards of loose brush, 2,676 cubic yards of brush made into fascines, and 1,004 tons of rock.

Eight dams were built, altogether, four on each bank. The lengths of those on the right bank, starting from the one farthest upstream, are, respectively, 128, 152.6, 140.8, and 63.9 feet. The lengths of those on the left bank are, respectively, 73.3, 113, 137.3, and 125.2 feet. The dams are composed of two rows of piles starting from the bank and running into the stream nearly at right angles to the current. Between the piles, and for about 15 feet on both sides of them, mattresses made of brush fascines were placed; loose brush was also put in where necessary, and the entire filling weighted with rock. On the shore ends of the dams the bank was protected with mattresses weighted with rock; this rock and brush protection was continued up the bank to high-water level. A dolphin composed of three piles with their tops 5 feet above high water was placed at the outer end of each dam to mark the channel.

The dam built to close Jacob break was found to be weakened in one or two places, and slight repairs were made to it in October and November, 1894. The weak places were strengthened with 600 cubic yards of earth, and places which were exposed to the heavy wash of the waves were protected with 327 cubic yards of brush mattresses, putting the dam in good condition. The cost of this work was $226.50.

The surveys of the Feather River to its mouth and of the Sacramento from the mouth of the Feather to its own mouth were undertaken when the river was at its low stage. Two parties were put into the field. One started from Marysville, the head of navigation on the Feather River, and worked downstream. This party completed the survey of the Feather River to its mouth, and also that of the Sacramento River from the mouth of the Feather to the city of Sacramento. The other party started from Sacramento and had completed the work as far as Ryde, when they were compelled to stop work for the season on account of the inclement weather.

Borings were made in the bed of the Yuba River during October and November, 1894, in order to ascertain the nature and extent of the deposits from hydraulic mining. They were made above Marysville and below Daguerre Point. Twenty-three borings were made in all. The shallowest boring to reach the natural gravel was 6 feet and the deepest 28 feet. The aggregate depth of the 23 borings was 366 feet.

Amount expended and results obtained during the past fiscal year.—The amount expended on the Sacramento and Feather rivers during the past fiscal year was $33,426.29, making the total amount thus far expended $611,741.21.

The snagging has been of the greatest benefit to navigation. The river is in good steamboating condition to the head of navigation at Red Bluff, and steamboats have run there regularly during the whole year.

The wing dams at Heacock Shoals were completed just before the annual rise of the river, and as the low-water stage will not be reached before August or September, 1895, their effect can not yet be determined.

The wing dam at the bridge at Sacramento has answered the desired purpose of removing the shoal formed in the draw of the bridge, and since its completion there has been no trouble at that point.

The snagging on the Sacramento River during the past fiscal year has been under the charge of First Lieut. Graham D. Fitch, Corps of Engineers, and Assistant Engineer H. L. Demeritt, and the work has been well and satisfactorily done.

General remarks on the rivers.—The Board of Engineers, which made its report in 1891, recommended appropriations for the treatment of shoals at Newtown, Iron-house, Ida Island, Heacock, and Sutterville, and expressed the opinion that a proper system of channel improvement applied at above points must result in obtaining about 7 feet of water in that part of the river at low stages, which is regarded as sufficient to meet all present requirements of navigation.

In the low-water stage of 1892 surveys were made at each of above shoals, with a view to devise a plan for the treatment of each separate shoal, when it was found that, with the exception of Heacock Shoal, each had a good channel over it exceeding 7 feet in depth. In the meantime Congress appropriated, on July 13, 1892, $150,000 for continuing improvement on the Sacramento and Feather rivers in accordance with the plan of the Board of Engineers, and also required treatment of the Yuba River near and above Marysville. It would have been useless to have spent this money on shoals which had more than the required depth of water on them, and surveys and borings had to be made in the Yuba to determine the best plan of treatment for that stream.

The surveys and borings, as far as they could be made, determined certain facts on which plans were made. These were approved, and resulted in the making of a new mouth for the Yuba River, which, when completed, was of great benefit to the people of Marysville, in that it immediately relieved them from danger of being flooded from freshets.

Additional surveys also permitted of the making of plans and projects for the treatment of Heacock Shoals, and the improvements at this locality were completed in 1894. In the meantime, as there had been no complete surveys of the Sacramento and Feather rivers since 1879–80 and radical changes in each had occurred since, authority was asked and obtained to make a resurvey of each of these rivers, extending from the head of navigation on the Feather to the mouth of the Sacramento. This survey was begun in 1894 (October), is completed for the Feather and down the Sacramento as far as Ryde, some 46 miles below the mouth of the Feather, leaving some 40 miles, more or less, of survey of the Sacramento (including the steamboat slough) yet to be completed. This will be done during the low-water season of October and November, 1895. On the completion of this survey data will be available showing the exact condition of the whole river, when it will be practicable to make plans and estimates for its systematic treatment.

In August, 1894, Congress again appropriated a further sum of $115,000 for continuing improvement of the Sacramento and Feather rivers, *including treatment of the Yuba and of the Bear*, and specifying that $10,000, or so much thereof as may be necessary, shall be expended *in snagging and other work between Tehama and Redding, on the Sacramento River*, and $10,000, or so much thereof as may be necessary, *in making a cut-off to avoid Shanghai Bend on the Feather River.*

That part of the appropriation relating to snagging between Tehama and Redding covers about 71 miles of river, of which 54 miles is between Red Bluff and Redding.

This latter stretch of river had at that time never even been officially examined, and hence no recommendation from any Government official had ever been made for its improvement. Red Bluff has for many years been the practicable head of navigation, and an iron bridge without a draw practically bars navigation beyond. Above this bridge and below Redding are two other bridges, both without draws, besides some forty or more rapids having in the aggregate a fall of approximately 251 feet in something like 54 miles of distance, or an

average slope or fall of a little less than 5 feet per mile. An examination of this part of the river was made by Lieutenant Fitch, Corps of Engineers, whose report thereon was forwarded to the Department. As this examination and report furnished excellent reasons why Government funds should not be spent on this portion of the river, authority was asked to make a survey of it, and that a Board of Engineers be convened to consider this survey and determine therefrom whether or not this part of the river was worthy of improvement.

The survey between Red Bluff and Redding will be completed in October or November, 1895, and the Board to consider the survey has been detailed.

With reference to cutting off Shanghai Bend in the Feather River, that subject had never been examined, and consequently had never been reported upon. As the survey of the Feather has since been completed, and includes Shanghai Bend, a separate report on the project has been submitted. For reasons therein stated it was recommended not to make the cut-off.

With reference to the Bear River, also mentioned in the appropriation act of 1894, it may be said that this is not and never has been a navigable stream. It is what might be called a flashy stream, nearly dry in summer and a torrent in winter freshets. It is a tributary of the Feather, entering the latter some 19 miles below Marysville and a short distance above the village of Nicolaus. Prior to 1884 much hydraulic and placer mining was in progress on the Bear and its tributaries and large quantities of mining débris were lodged in the bed of the stream. During freshets much of the mined material was carried down toward the mouth of the river, where it spread over hundreds of acres of territory, and some of it undoubtedly reached the Feather River. During the past ten years there has been but little hydraulic mining on this stream, and with such as has been permitted the débris has been cared for and impounded behind dams. Its bed at and near its mouth is now so wide that, even in freshets, its flow at this locality is not concentrated, and it carries but a small proportion of débris into the Feather in comparison to what it did ten or more years ago. At and for fully 5 miles below the mouth of the Bear the Feather has a least channel depth of 5 feet or more and is in better navigable condition than any other portion of its navigable length, 30 miles, from which it is concluded that this portion of the Feather needs no improvement and that the Bear River is not at present damaging, nor has it recently damaged, the Feather to any extent sufficient to warrant any expenditure of money on Bear River. The above remarks are in explanation of why money appropriated in the act of 1894 was not used in upper Sacramento River above Red Bluff, on the Feather River near Shanghai Bend, and on the Bear River. But they do not explain why more money appropriated in the acts of 1892 and 1894 was not spent in the Yuba improvement and in other parts of the Sacramento River. This will now be apparent. The new mouth made for the Yuba River in 1893 was of decided advantage, and assisted in lowering the bed of the stream below Daguerre Point. Surveys and borings in the bed of the stream, which is not navigable, and which it is not attempted to make navigable, show such a decided improvement in its condition that it has not yet been determined where and to what extent further work of improvement, if any, may be necessary.

As has been elsewhere stated, the shoals in the lower Sacramento River disappeared, or improved, to such an extent that it became unnecessary to spend any money for their betterment. Navigation has been maintained without interruption, and only such places were improved as

commerce and navigation demanded. The result is as good a river as the Board of 1891 contemplated on the Sacramento, and a balance available of $146,064.79.

This can be applied by continuing snagging, building wing dams, and generally in improving and maintaining navigation on the Sacramento and Feather rivers, and it is believed to be sufficient for this purpose until June 30, 1897; hence no additional appropriation is asked.

Remarks.—The commerce of the Sacramento River is carried on 8 steamers, 16 grain barges, and 7 brick barges belonging to the Sacramento Transportation Company; 5 steamers and 7 barges belonging to the California Transportation Company, and 2 steamers belonging to the Southern Pacific Company. The steamers vary in size from 183 to 619 tons, averaging 303 tons, and the barges from 118 to 800 tons, averaging 600 tons. The larger of the steamers only go a short distance up the river, the commerce of the upper river being carried on barges towed by light-draft steamboats.

On the Feather River a small steamer, 247 tons gross tonnage, belonging to the Southern Pacific Company, makes one round trip per week, with a barge, and takes all the freight that offers.

There are inclosed herewith rod records showing the stage of the Sacramento River at Red Bluff from January 1, 1894, to December 27, 1894; at Tehama from October 1, 1894, to May 31, 1895; at Chico Bridge from December 1, 1894, to May 31, 1895, and at Colusa from December 1, 1894, to May 31, 1895.

Records of the stage of the river are now regularly kept at Tehama, Chico Bridge, and Colusa, in connection with the work of improving the river.

There is also inclosed a tracing and blue print of the survey of the Feather River, from Yuba City to the mouth of the river.*

Money statement.

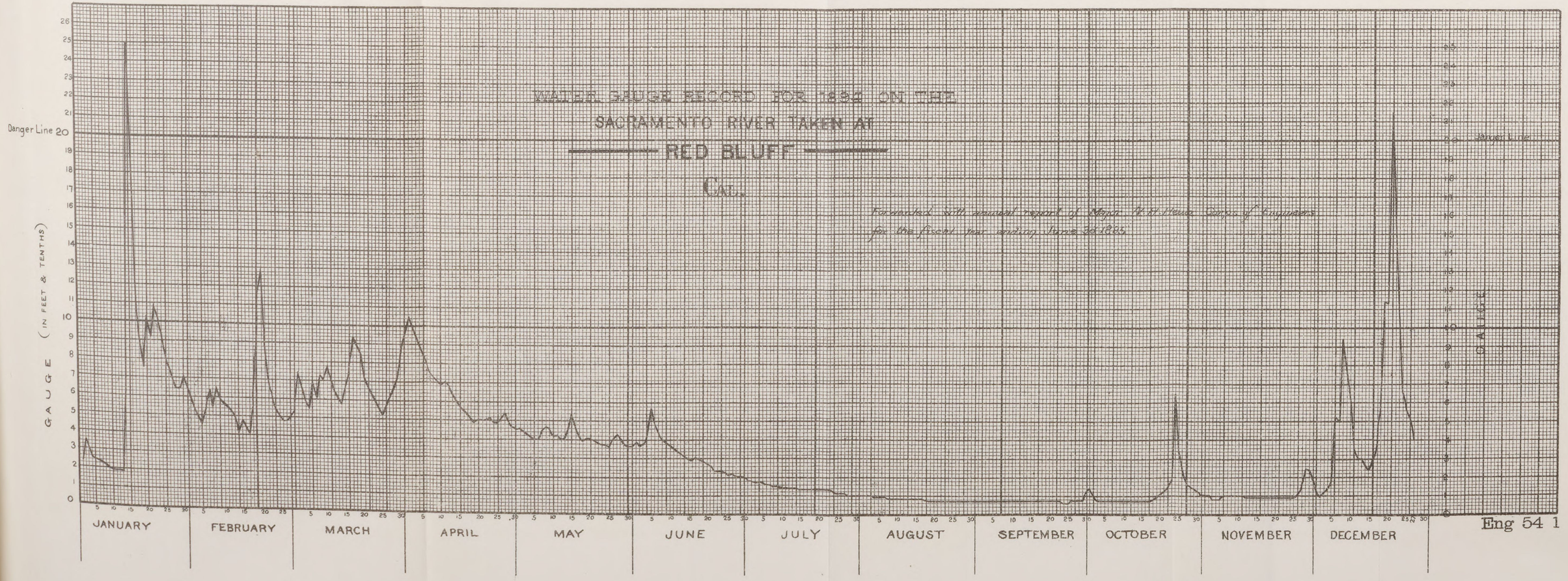
July 1, 1894, balance unexpended	$65,685.08
Amount appropriated by act of August 17, 1894	115,000.00
	181,685.08
June 30, 1895, amount expended during fiscal year	33,426.29
July 1, 1895, balance unexpended	148,258.79
July 1, 1895, amount covered by uncompleted contracts	2,194.00
July 1, 1895, balance available	146,064.79
Amount (estimated) required for completion of existing project	(†)
Amount that can be profitably expended in fiscal year ending June 30, 1897	(‡)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

STATISTICS OF TRADE OF THE FEATHER RIVER.

The following statement, showing the number of tons of freight carried on the Feather River by the steamers of the Southern Pacific Company during the year from June 1, 1894, to May 31, 1895, was furnished by Mr. E. C. Wright, the general auditor of the company:

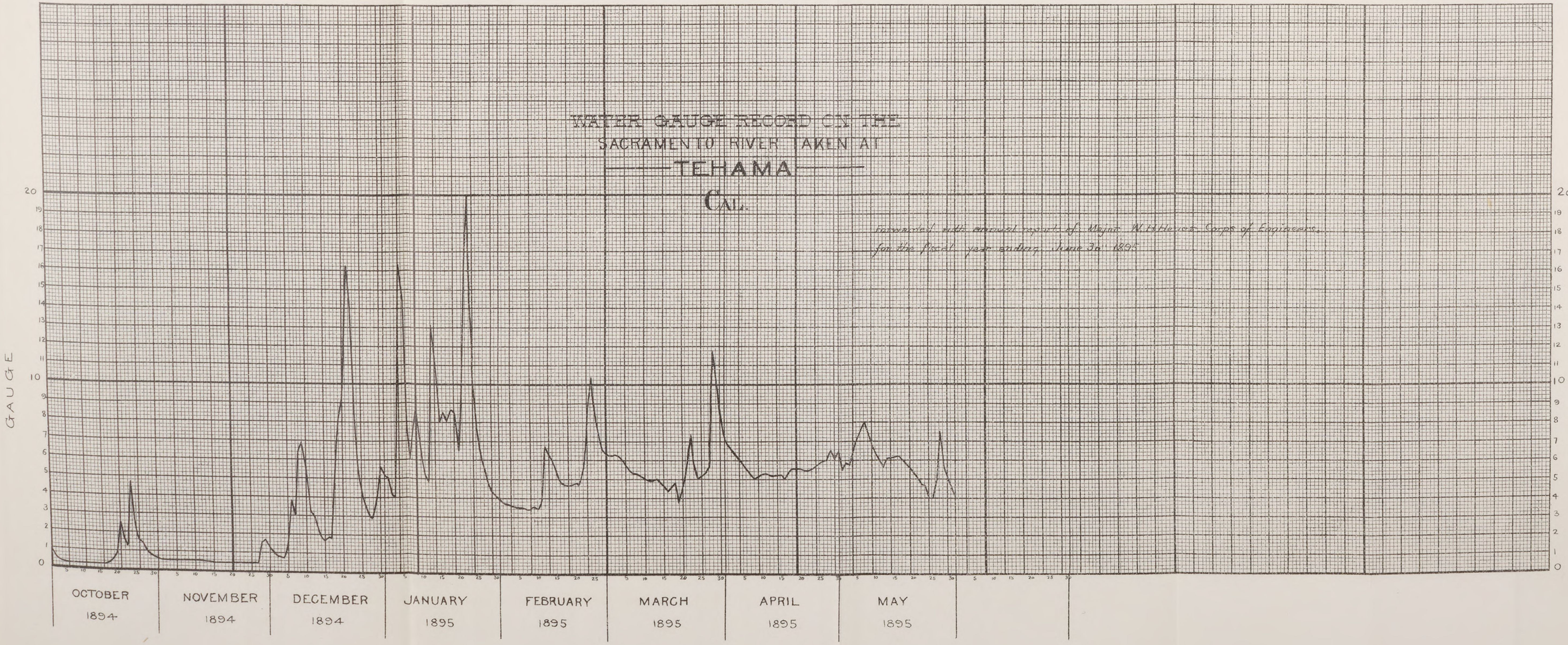
	Tons.
Freight carried north	16,217
Freight carried south	9,488
Total freight carried	25,705

*Not printed. †Indeterminate. ‡Sufficient on hand.


WATER GAUGE RECORD FOR 1894 ON THE
SACRAMENTO RIVER TAKEN AT
RED BLUFF
CAL.
Forwarded with annual report of Major H. M. Chittenden Corps of Engineers
for the fiscal year ending June 30, 1895
GAUGE (IN FEET & TENTHS)
Danger Line 20
JANUARY
FEBRUARY
MARCH
APRIL
MAY
JUNE
JULY
AUGUST
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
Eng 54 1

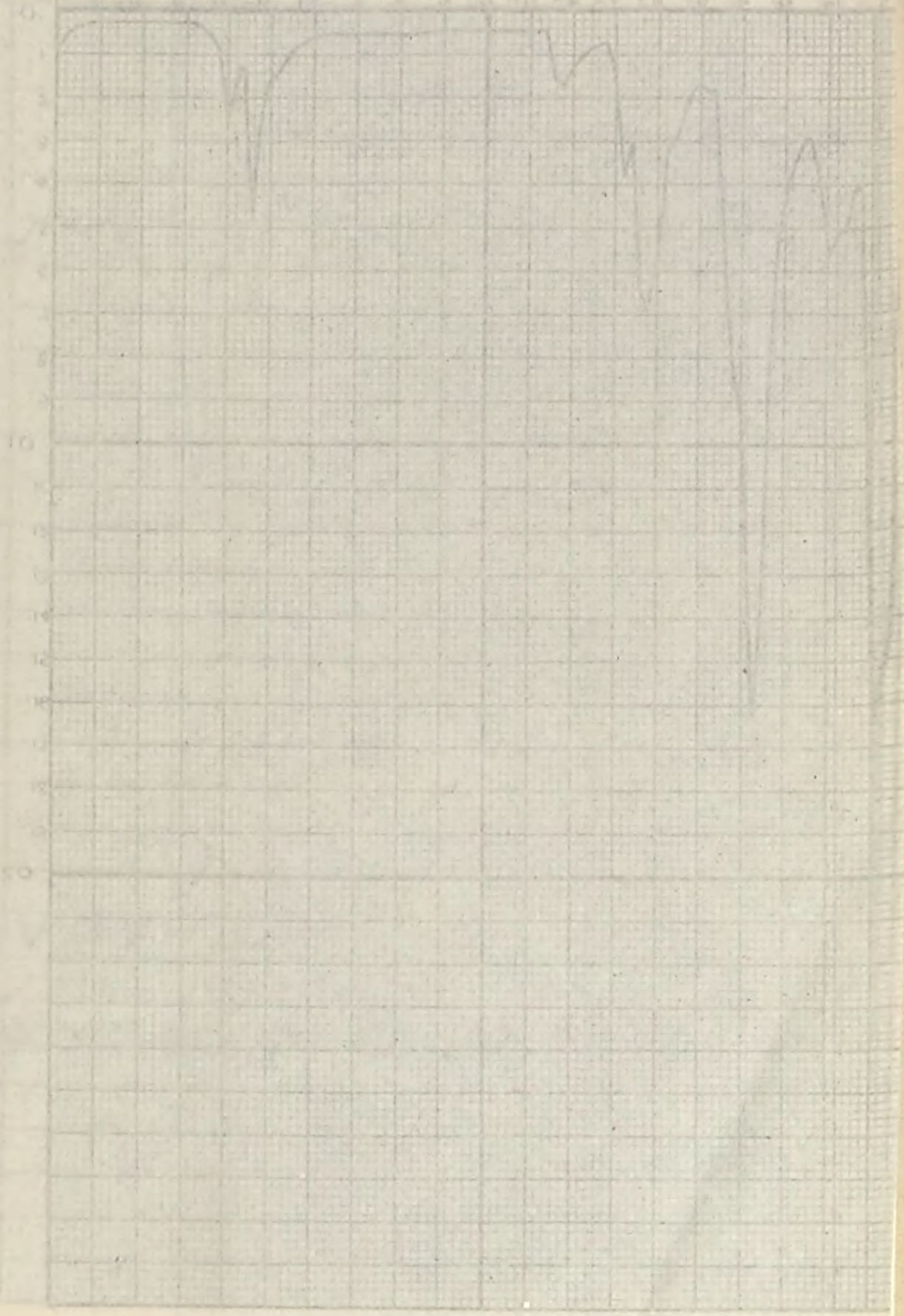
WATER GAUGE RECORD ON THE SACRAMENTO RIVER TAKEN AT TEHAMA CAL.

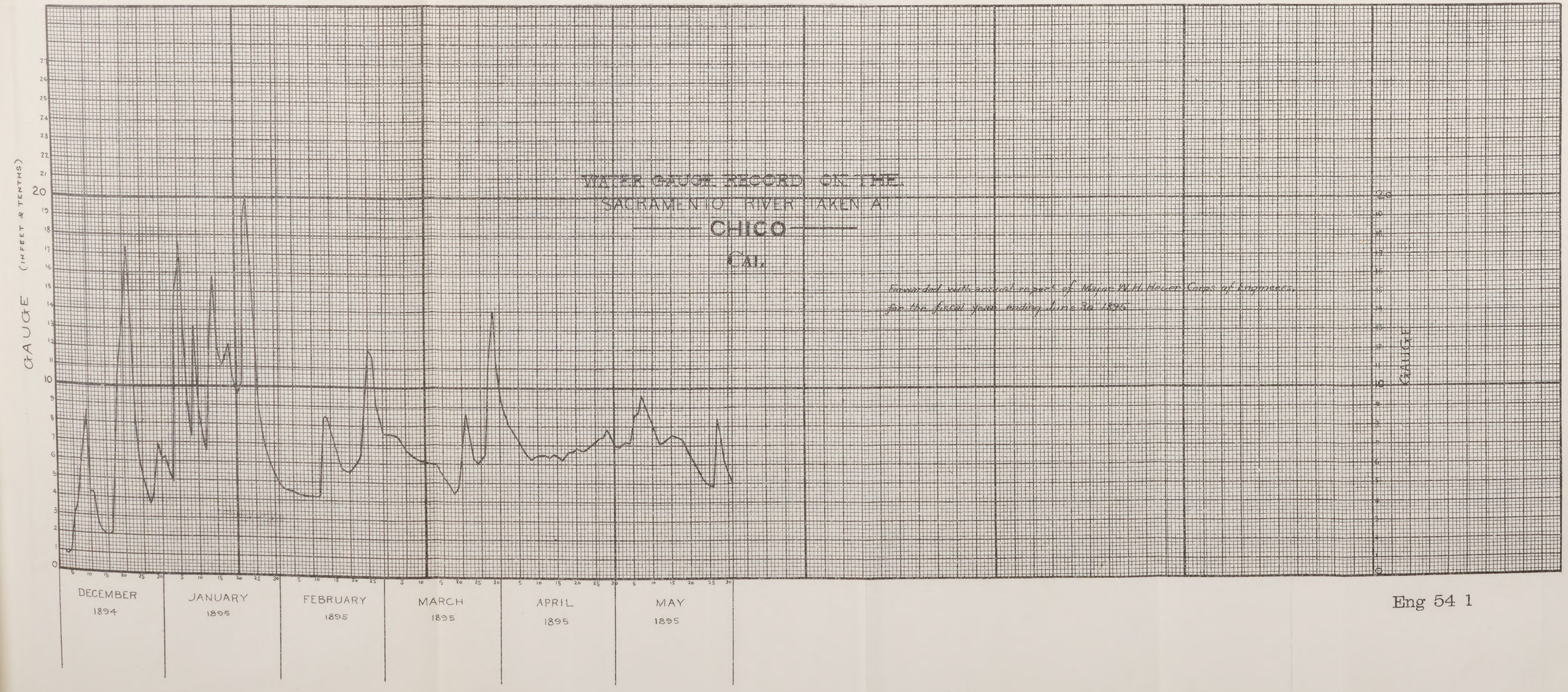
Forwarded with annual report of Major W. H. Heuer, Corps of Engineers, for the fiscal year ending June 30, 1895



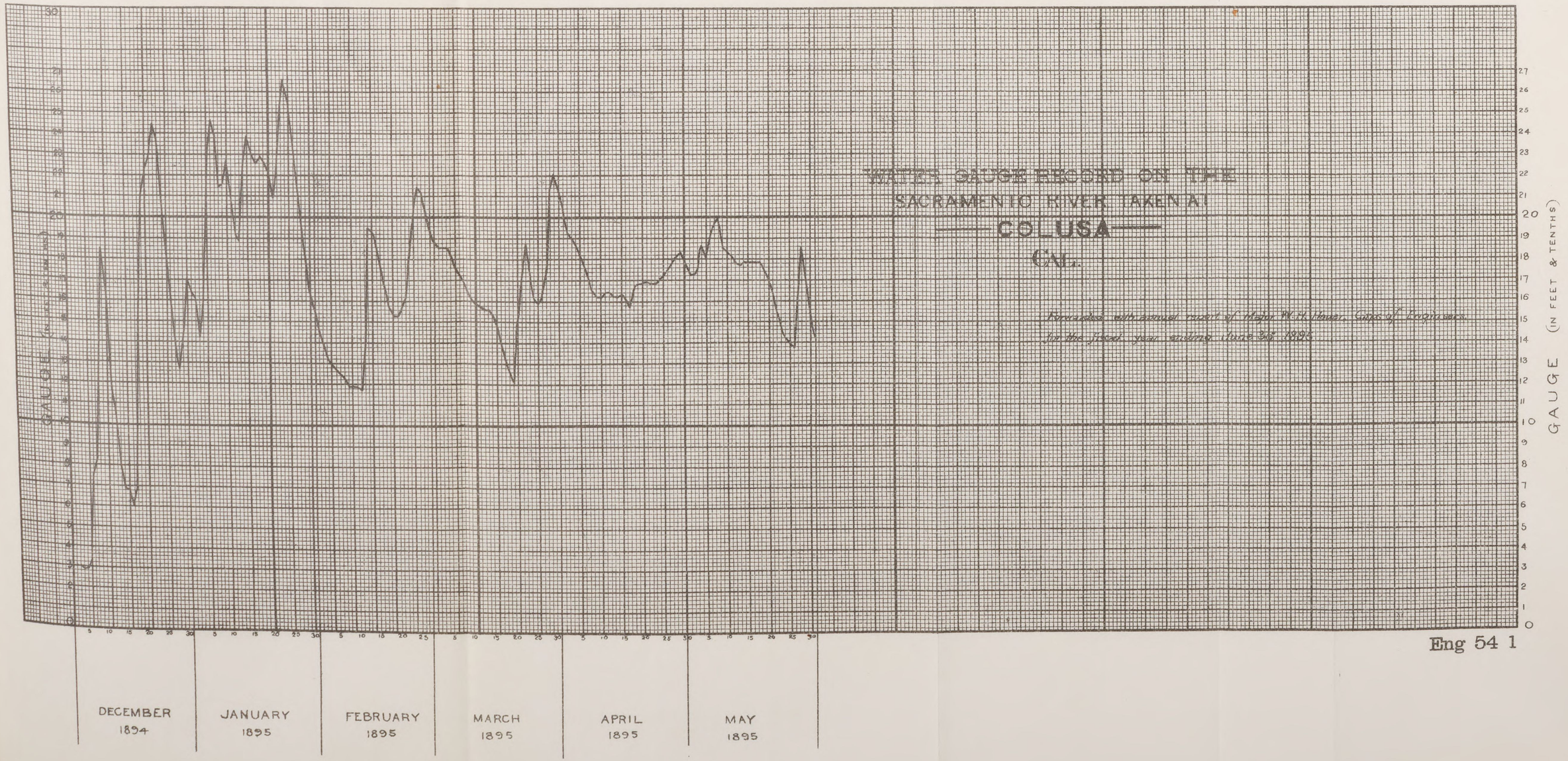
OCTOBER NOVEMBER DECEMBER

1894 1894 1894




WATER GAUGE RECORD ON THE
SACRAMENTO RIVER TAKEN AT
CHICO
CAL.
Forwarded with annual report of Major W. H. Heuer Corps of Engineers
for the fiscal year ending June 30 1895
GAUGE (IN FEET & TENTHS)
GAUGE
DECEMBER 1894
JANUARY 1895
FEBRUARY 1895
MARCH 1895
APRIL 1895
MAY 1895

Eng 54 1



WATER GAUGE RECORD ON THE
SACRAMENTO RIVER, TAKEN AT
—COLUSA—
CAL.

Forwarded with annual report of Major W. H. Heuer, Corps of Engineers,
for the fiscal year ending June 30, 1895.

Eng 54 1

STATISTICS OF TRADE OF THE SACRAMENTO RIVER.

The following statement, showing the freight, in tons, carried on the Sacramento River by the steamers of the Southern Pacific Company during the year from June 1, 1894, to May 31, 1895, was furnished by Mr. E. C. Wright, general auditor of the company:

	Tons.
Freight carried north	39,614
Freight carried south	27,206
Total freight carried	66,820

The above includes all way freight.

The following freight was brought from the Sacramento River, above Sacramento, by the steamer *Ellen*, Capt. A. F. Williams, owner, during the year from June 1, 1894, to May 31, 1895:

	Tons.
Wheat	12,486
Barley	998
Total	13,484

The following statement of the freight carried by the boats of the California Transportation Company during the year from June 1, 1894, to May 31, 1895, was furnished by Capt. N. Anderson, the secretary of the company. These boats only go as far as Clarksburg, about 55 miles above the mouth of the river:

	Tons.
General merchandise	89,633
Lumber	8,000
Total	97,633

The following statement of the freight carried on the Sacramento River by the boats and barges of the Sacramento Transportation Company was supplied by Capt. J. H. Roberts, the president of the company, who states that before the opening of the river from McIntosh Landing to Red Bluff the freight rate on wheat, by railroad, from Tehama and Red Bluff to tide water was $3.50 per ton, whereas since the river has been opened it has been reduced to $2.80 per ton, the rate by river being $2.70 per ton, and also that on up freight rates, on merchandise, there has been a reduction of from 20 to 30 per cent:

UP RIVER FREIGHT.

	Tons.
From San Francisco to Sacramento:	
Lumber	20,000
Coal	13,000
Merchandise	18,370
From San Francisco and Sacramento to upper river below Red Bluff:	
Lumber	3,508
Merchandise	4,581
From San Francisco and Sacramento to Red Bluff:	
Merchandise	2,610
Lumber	160
Total up freight	62,229

DOWN FREIGHT.

Sacramento to San Francisco:	
Merchandise	2,500
Brick	27,000
Flour	1,000
Miscellaneous	2,000
Upper river to Sacramento:	
Cord wood	11,400
Broom corn	150
Grain	4,533
Potatoes	2,200
Cattle and hogs	145
Miscellaneous	1,000

Upper river to San Francisco and Port Costa:	Tons.	
Wheat	118,509	
Hay	6,187	
Broom corn	551	
Wool	366	
Cattle, sheep, and hogs	340	
Fruit, dried and green	300	
Flour	200	
Miscellaneous	1,000	
		Tons.
Total down freight		179,481
Total freight carried		241,710

The down freight shown above was brought from the following points:

	Tons.
Sacramento and below	32,500
Above Sacramento and including McIntosh	134,852
Above McIntosh and including Tehama	10,721
Above Tehama	1,408
Total	179,481

The total freight carried on the Feather River during the year as reported by the shippers was 25,705 tons, and on the Sacramento River 419,647 tons.

S S 4.

IMPROVEMENT OF PETALUMA CREEK, CALIFORNIA.

Description.—Petaluma Creek, which is really an estuary, extends from San Pablo Bay to the town of Petaluma, about 16 miles, and is the outlet for a large amount of freight from a large agricultural district.

Original condition.—Before improvement the channel was very crooked, and in places dry at low water, making navigation difficult and uncertain.

Work prior to June 30, 1894.—In 1880 a project for its improvement was adopted which had for its object to obtain by dredging a channel 50 feet wide and 3 feet deep at low water and to straighten it by cut-offs. Contracts were let for this purpose, and work carried on in 1880, 1881, 1882, and 1884, when the project was completed by the removal of 89,692 cubic yards of material at a cost of $27,656.91. As the creek receives the drainage of a highly cultivated region of considerable area, the channel is constantly refilling. In 1888 the channel was again dredged to a width of 40 feet and depth of 1 foot below low water. This cost $2,116.30, and partially relieved the immediate wants of navigation. The channel again filled up, and when funds became available in 1891 a contract was let to redredge it. This resulted in a channel 6,800 feet long by 40 to 45 feet wide, with a depth of 3 feet to 30 inches below low water. This time 37,005 cubic yards of material was excavated at a cost of $5,846.36. This exhausted the available funds, and work was stopped. In 1892, another appropriation having been made, the creek was surveyed and a project submitted for its improvement. This project, which contemplated the excavation of a channel 50 feet wide and as long and deep as funds would permit, was approved. Work under it was commenced May 2, 1893, and terminated September 10, 1893, when the funds were exhausted. This resulted in a channel from Haystack Landing to the town of Petaluma 50 feet wide and 3 to 4 feet deep at low water. This work was done by the Government

dredge, and 88,035 cubic yards of material was excavated at a cost of 9.9 cents per cubic yard, including all office, engineering, and contingent expenses.

Amount expended and results obtained to June 30, 1894.—The amount expended on Petaluma Creek up to June 30, 1894, was $45,858.05. The result was a channel up to the town of Petaluma, which was of the greatest benefit to commerce.

APPROPRIATIONS.

June 14, 1880	$8,000	July 13, 1892	$10,000
March 3, 1881	8,000	August 17, 1892	15,000
August 2, 1882	14,000		
August 11, 1888	2,000	Total	61,000
September 19, 1890	4,000		

Report of operations during the past fiscal year.—The channel having somewhat refilled in the fall of 1894, and funds being available, bids were invited for redredging the channel. These were opened on November 12, 1894, when the following were received:

	Cents.
Will. S. Bliss, San Francisco, Cal., per cubic yard	14⅔
Pacific Coast Dredging and Reclamation Company, San Francisco, Cal., per cubic yard	17

As both these bids were excessive in price they were rejected and the work postponed until the spring of 1895. Bids were again invited and opened April 18, 1895. The following were then received:

	Cents.
Pacific Coast Dredging and Reclamation Company, San Francisco, Cal., per cubic yard	15
A. W. Von Schmidt, San Francisco, Cal., per cubic yard	10

Of these bids, that of the Pacific Coast Dredging and Reclamation Company was excessive in price, and that of A. W. Von Schmidt was so informal that it could not be accepted. They were therefore both rejected. The work was again postponed until the Government dredge was available.

Amount expended and results obtained during the past fiscal year.—The amount expended during the past fiscal year was $79.24, making the amount thus far expended $45,937.29. As no work was done no further results were obtained.

Future operations.—Although the channel has shoaled somewhat since the last work was done in 1893, there is only one bar which really forms a serious impediment to navigation, and that only at low water. As the range of the tide is some 6 or 7 feet, vessels reach Petaluma at half and high tide stages, but the movements of the regular steamer are interfered with when it so happens that her scheduled time of arrival or departure is coincident with the time of low water.

As soon as the repairs to the U. S. dredge which are now in progress are completed, this bar will be removed and the channel redredged up to the town of Petaluma to such a width and depth as the funds will permit. This will give a good boating channel to the head of navigation, which will not require further improvement up to the end of the fiscal year ending June 30, 1897. For this reason no additional funds are asked for.

Remarks.—The commerce of Petaluma Creek is carried on one steamer, the *Gold*, 294 tons, which makes six round trips per week from San Francisco; also on numerous scow schooners which carry the heavier freight.

The large and important commerce which is carried on this stream is that of a flourishing and constantly increasing agricultural community as well as of several manufacturing industries. It considerably influences railroad freight rates, not only from points actually on the creek, but also from all points within hauling distance. As the channel is not self-maintaining, it requires redredging about once every two years.

Money statement.

July 1, 1894, balance unexpended	$141.95
Amount appropriated by act of August 17, 1894	15,000.00
	15,141.95
June 30, 1895, amount expended during fiscal year	79.24
July 1, 1895, balance unexpended	15,062.71
Amount (estimated) required for completion of existing project	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1897	(†)
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

Application was made for the statistics of trade of this creek, which is large and important, but they could not be obtained.

S S 5.

IMPROVEMENT OF HUMBOLDT HARBOR AND BAY, CALIFORNIA.

Description.—Humboldt Bay, lying in latitude 40° 46′ N., or 230 miles north of San Francisco, is an estuary about 14 miles long with its larger axis parallel to the ocean. It is separated from the sea by two narrow tongues of sand, which extend to high land both on the north and south, and between these lines the channel which communicates with the sea. The bay has a high-water area of about 24 miles and a low-water area of about 13 square miles. The tide has a mean rise and fall of 4 feet 4 inches, becoming 8 feet or more at springs and less than 3 feet at neaps.

The average tidal discharge is about 100,000 cubic feet per second.

Humboldt Bay is the only landlocked harbor in California north of San Francisco, and is the most important lumber port of the State.

Original condition.—Before improvement entrance to the harbor was obstructed by a bar, the entrance over which was by a channel variable in position (from southwest to northwest 1½ miles apart at the sea ends), variable in depth (from 9 to 25 feet), in width (from 2,200 to 4,200 feet). There were also numerous shoals within the harbor, close to the wharves, rendering it difficult for vessels to reach Eureka, Arcata, and Hookton.

Work prior to June 30, 1894.—In 1881 a project was adopted with a view to securing, by dredging, a channel 13 feet deep and 200 feet wide to the head of Eureka wharves, and one of 10 feet deep and 100 feet wide to Arcata and Hookton. This portion of the project was completed in 1884 at a cost of $80,884.69. These channels have since silted up materially and are again an impediment to commerce and ought to be redredged.

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* Indeterminate. † Sufficient on hand.

In 1882 an additional project was adopted with the object of increasing the depth over the bar at the entrance to the harbor by constructing a low-tide stone jetty, extending seaward from the south spit for a distance of 6,000 feet. Its estimated cost was $600,000. The money appropriated was not available until certain land required was obtained free of expense to the Government, hence nothing could be done until 1888, when a contract was let under the above project. Operations were begun in 1889 and carried on until October, 1890, when the contractor failed.

Under this contract the south jetty was built out 2,767 feet, 900 feet of the length being raised to high-water level.

In October, 1890, a Board of Engineers recommended two high-tide stone and brush jetties, starting from the north and south spits, respectively, and extending seaward to the 18-foot contour. The north jetty was not to be begun until the completion of the south. The cost of the two jetties was estimated at $1,957,615.

This project was adopted, and in May, 1891, work was begun under another contract and continued until December, 1891. Under this contract 300 linear feet of brush mattress and stone protection work was built to arrest erosion of the north spit; a stone and brush dike was commenced and carried out on the north spit, 1,480 feet in length, and the south jetty was extended 600 feet, making it 3,699 feet long; this completed the contract.

No work was done from December, 1891, to April, 1893, owing to lack of funds.

On account of continued erosion of the north spit the project was slightly modified in 1892, as recommended by a Board of Engineers, so as to make the previously built dike a part of the jetty.

The north jetty was relocated, and its construction authorized to a point sufficient to arrest erosion without awaiting the completion of the south jetty.

Funds having been appropriated by the river and harbor act of July 13, 1892, and the improvement placed under the so-called continuous-contract system, proposals for the work were invited.

On December 16, 1892, a contract was entered into with John C. Bull, jr., the lowest bidder. Work under this contract was commenced April 14, 1893 (on which date the first load of stone was delivered on the north jetty), and construction continued during the season up to February, 1894, when it was closed down and not resumed until the latter part of April, and from that time to the close of the fiscal year carried on without intermission. During this fiscal year the work done amounted to 2,674 feet of trestle, 14,343 cubic yards of brush, and 72,483 tons of rock, making the north jetty 5,178 feet long, of which 3,767 feet was completed to full height.

South jetty.—Owing to the channel encroaching too closely to the line of the jetty a few short spurs of rock and brush were built to divert the current at the points most threatened. No other work was done on the south jetty with the exception of placing 15,836 tons of rock as a revetment on the south side and filling up a few gaps. For this work 555.23 cubic yards of brush and 19,758 tons of rock were used. The south jetty was at this time 3,699 feet long.

The total amount earned by the contractor up to June 30, 1894, was $219,111.64.

Amount expended and results obtained to June 30, 1894.—The amount expended on jetty work up to June 30, 1894, was $495,598.90. A reasonably fixed channel of 24 feet depth and about 950 feet in width had been

maintained during the latter part of the year, and no vessels were detained owing to insufficient water. Vast quantities of sand were impounded on the outside of both jetties which without them would probably have been carried into the entrance.

APPROPRIATIONS.

March 3, 1881	$40,000	July 13, 1892	$150,000
August 2, 1882	40,000	March 3, 1893	522,000
July 5, 1884	62,500	March 2, 1895	225,000
August 5, 1886	75,000		
August 11, 1888	125,000	Total	1,319,500
September 19, 1890	80,000		

NOTE.—Of the above amounts appropriated $80,884.69 was expended for dredging, and forms no part of the present project.

Report of operations during the present fiscal year.—At the beginning of the fiscal year work was in progress under the continuous contract made with John C. Bull, jr.; Lieut. Herbert Deakyne, Corps of Engineers, remained in local charge.

The beginning of the fiscal year found operations on the jetties in progress, which continued until the close of the season in January, 1895. The work was vigorously pushed. The deliveries of material and construction of trestle was much greater than for the corresponding months of the previous year.

South jetty.—Owing to the deep water at and beyond the end of this jetty, caused by a shifting of the channel to the southward, no work of extension had been done for two years. A few short groins were built to divert the current which had encroached dangerously on the line of the jetty. These groins were only practicable where the water deepened gradually from the jetty to the channel; where the slope was abrupt it was found difficult to properly sink the mattresses or to keep the rock in place. They were of some benefit, but accumulated sand less rapidly than was expected.

For this reason the experiment was tried of revetting the slopes of sand next the channel, where it threatened to undermine the jetty, with rock both large and small dumped from the trestle. This revetment was made continuous for a length of 1,056 feet from bent 150 to bent 216, the end of the existing trestle. In this revetment during July and August 8,460 tons of rock was used. At this time the depth of water parallel to the line of the jetty and 70 feet out from its center, from bent 150 to bent 215, varied from 15 to 40 feet, averaging 32 feet. The rock when dumped took a slope of 4 on 5, but soon flattened out to 2 on 3. The crest of the revetment was built up to the height of the jetty alongside, but later in the season this height was somewhat reduced by the sea. This enrockment served its purpose and protected the jetty proper from being undermined. To enable this revetment to be placed the trestle had to be repaired as far as bent 208 and rebuilt from that point outward to bent 216. The operation of driving piles through the rock of the jetty did not prove so difficult as was anticipated; a penetration varying from 6 to 18 feet was secured.

After the work of revetment was completed it was desired to extend the south jetty, but surveys beyond its outer end still disclosed depths of water from 35 to 50 feet, in which depth jetty work was considered too expensive, especially as past experience led to the belief that this condition was only temporary and that the constantly recurring changes would again move the channel northward and cause shoaling, there-

after rendering extension work feasible. On August 16, 1894, therefore, work on the south jetty was discontinued.

During September and December, 1894, and January and February, 1895, considerable damage was done by violent storms. Fifty-one bents were destroyed or seriously damaged, one-third of the piles having been carried away back to bent 160. The last bent standing was 165.

In March, 1895, soundings off the end of the jetty showed changed conditions; considerable shoaling had taken place. The channel, which had formerly crossed the line of the south jetty, had shifted to the northward, and for a distance of 1,000 feet ahead of the trestle there was depth of only 18 to 22 feet where formerly it had been 35 to 50 feet. This condition was favorable for extension work and preparations to that end were commenced.

Pile driving for repairs to the trestle was begun May 4, and by the end of the month the trestle was again intact to bent 181.

During June, 1895, this work was continued, and by the end of the fiscal year the trestle had been rebuilt to bent 230, a length of 3,682 feet. The length of the original trestle was 3,699 feet, so the work of replacing former trestle was practically completed.

The depth of water at bent 230 is 25 feet; on the proposed line of the extension of the jetty it has deepened since March to about 28 feet.

North jetty.—The beginning of the fiscal year found the work of construction of this jetty in full operation. During July, August, and the early part of September the weather was unusually favorable. Excellent progress was made—better, in fact, than at any former period of the work—but in September severe gales and heavy seas commenced, and from that time on the work on the trestle was more in the nature of repairs than extension. At the beginning of September the trestle was built to bent 393, a length of 6,300 feet beyond the initial point; during the month this was carried to bent 423, when a storm commenced which carried away the outer bent, broke one pile in bent 405, and did other slight injuries. In October the trestle was repaired and extended to bent 431, when another storm carried away 9 bents back to bent 423, and broke 7 piles inshore from that point. In November the trestle was again repaired and extended to bent 427, and extra fastenings put on, but was again destroyed on the 27th, 4 bents being lost, which left the trestle standing to bent 423, the point reached in September.

In view of these repeated disasters it was decided to stop extension at this point for the winter, strengthen the outer end, and confine the operation to building up the stonework.

Accordingly, the 6 outer bents were reenforced with extra bolts and straps. In January, 1895, a severe gale caused the destruction of 30 bents back to bent 388, and took out 31 piles between bents 364 and 385. This left the outer 6 bents standing alone, with a gap 32 bents or 512 feet long intervening between them and the nearest inshore portion of the trestle. This was the condition February 8, 1895, when work was suspended. During the latter part of February these 6 outer bents were destroyed.

In April, 1895, reconstruction was begun, and in spite of bad weather repairs were made out to bent 405. In May the trestle was repaired and extended to bent 436. This new work was damaged by a storm on the 25th, 1 bent and 17 piles being lost, but by the end of the month the trestle was again rebuilt to bent 436.

The work during June consisted of extension of the trestle; piles were driven to bent 487, a length of 7,803 feet, and trestle completed to bent 473, a length of 7,579 feet.

Five different systems of fastening caps to piles were tried and were exposed to storms on May 25 and 27. These fastenings were—

First. A $\frac{7}{8}$-inch iron drift bolt alone.
Second. A $\frac{7}{8}$-inch iron drift bolt and a $2\frac{1}{2}$ by $\frac{3}{8}$ inch by 5 feet iron strap spiked to cap and pile.
Third. A 1-inch steel drift bolt and a strap as above.
Fourth. A $\frac{7}{8}$-inch iron drift bolt, strap as above, and two 4 by 6 inch pine braces per bent bolted to cap and piles.
Fifth. A $\frac{7}{8}$-inch iron drift bolt and a $1\frac{1}{4}$-inch iron screw bolt, with nut mortised in pile.

The only method that stood the storm without damage was the fifth. In the first three years of jetty construction sway braces were placed on piles of trestle to stiffen it until the enrockment was well up from the bottom. Occasionally these were broken by violent sea action during storms, and more frequently by rock being dumped on them from the cars above. In the past two working seasons sway braces have been omitted for the reason that their surface exposure to the waves was so great as to endanger the stability of the trestle. Other means to secure it were by extra fastenings to caps and stringers as detailed above.

In spite of these precautions 51 bents or 816 feet of trestle on south jetty and 46 bents or 736 feet of trestle on north jetty were destroyed during severe gales. Part of this loss had to be borne by the contractor, the larger part, however, occurring during the season when work was not in progress, had to be replaced at the expense of the Government.

That the trestle should be destroyed is not at all surprising when it is considered that during violent storms green waves sometimes break and curl over and across the top of this frail superstructure. Piles have been broken short off at and above their line of intersection with the rock jetty, and stringers 12 by 14 inches in size have been broken in two by the impact of these waves. The trestle has been made as strong as any reasonable expenditure of money would warrant. Where broken or destroyed it has to be repaired or renewed.

Mattress work.—The brush mattress work used during the year for foundation for the stone jetty were each two bents or 32 feet long by 48 feet wide by $3\frac{1}{2}$ feet thick; they were constructed on hanging stages under the trestle, loaded with small rock and sunk. This work followed trestle construction as closely as possible. The jetty built during 1894 was founded in a practically uniform depth of water, rarely more than 16 feet or less than 10 feet. The scour induced by the piles driven in extension was small. The average depth in which piles were driven was 13.6 feet and the average depth in which mattresses were sunk was 14.8 feet, making the average scour 1.2 feet.

Rock.—The rock used during the latter part of the past year was of better quality than heretofore, owing partly to improvement in the quarries and also to rigid inspection and rejections of rock thought liable to disintegrate. For some time past it had been observed that some of the rock delivered early in the work, where subjected to alternate exposure to water and air, showed signs of disintergration; thorough examination of this rock was made with a view to determine which of the several kinds furnished had proven to be bad. The result reached was that four kinds of rock delivered were unsuitable, viz:

A fine-grained blue rock full of seams and so soft that it crumbled in the hand;
A surface rock of yellow-gray color;
A conglomerate, crumbling on slight pressure; and
A rock containing seams of slate.

All rock of this character was rejected, as was also some for small size. Small rock was used for sinking mattresses, revetting the channels, slopes, and for hearting jetties; the large rock (1 ton and upward) for facings and tops of jetties.

During the past year the quantity of rock delivered in the north jetty was 197,216 tons, an amount largely in excess of any previous year in the history of the work. The largest monthly deliveries were for May and June, when 26,755 and 30,794 tons, respectively, were received and placed.

This increased output is due to the efficient management of Mr. W. E. Dennison. Since assuming charge, as manager, he has increased the plant principally by the purchase of additional scows, a new locomotive, new cars and the remodeling of many old ones, by which the train loads of rock can be handled regularly and without delay.

The quarries and the jetties are also connected by telephone line.

The electric-light plant installed at the quarries the year before enables quarrying to be carried on at night.

Spurs and revetment, north jetty.—In May, 1894, the high-water line was at bent 22. Scour occurred and this line receded toward the wharf and threatened to undermine the initial point of the jetty. To prevent this rock was dumped on the bay side. By October the scour was so pronounced that it became evident that other means must be resorted to to stop the erosion; consequently a piece of track was built, leaving the jetty at bent 18 and extending along the high-water line to the wharf. From this track shore protection work of brush and heavy rock was built; later this protection was carried on to the north side of the wharf. This accomplished its purpose and the cutting ceased.

Continued cutting near bent 92 compelled the construction of a spur, leaving the jetty at bent 75 and extending to a point 150 feet out from the center of the jetty. The effect of this spur was not altogether satisfactory; an eddy around its end first undermined the rock and finally carried away the outer portion. It is believed that it was the cause of the sinking of the jetty near bent 85, as at this point the eddy formed by the spur was particularly noticeable.

Another spur was built at bent 207 to protect a portion of the jetty built in shallow water. At this point the spur was exposed to the breakers. It stood during the past winter without material change in the spur itself or its surroundings.

In March, 1895, serious erosion took place near bents 50, 95, and 200. At these points the channel encroached dangerously near the jetty. To prevent undermining, revetment of the channel slope was immediately begun. In the vicinity of bent 95 17,000 tons of rock were placed in the revetment. It was brought up to 8 feet above low water from bent 75 to bent 110; from bent 110 to bent 115 it was brought up to 5 feet above low water, and from 115 to 120 to 2 feet above low water.

Near bent 200 the revetment was brought up to 2 feet above low water and extended to bent 202. At bent 50 to 75 the revetment was brought up to 4 feet above low water.

The jetty at these points is for the present safe.

The rock dumped in revetment did not retain the slope first assumed, but was flattened and spread out over the slope of the channel, thus forming a blanket of stone over the sand and preventing erosion.

The experience thus far on this work leads to the belief that the revetment of slopes has been more effective in checking undermining of the jetty than a system of spurs or groins, for the reasons:

First. That the revetment can be instantly applied whenever scour is manifested, whereas to construct a spur it is necessary first to build

a trestle from which to place the mattresses and rock, and serious injury may be done before this can be accomplished.

Second. The revetment does not change the channel alignment, but allows a smooth flow of the current over it. The spurs generally have caused eddies and whirls around them, which in a few cases caused their partial destruction, with probable injury to the jetty as well.

Third. Revetment is cheaper for the length of the jetty protected.

Further observation and experiment will be necessary to determine fully the best means to afford absolute security against undermining.

At the end of the fiscal year the trestle of the north jetty was complete to bent 473, a distance of 7,579 feet; mattresses sunk to bent 473 and jetty completed to bent 395, a distance of 6,329 feet.

The initial point from which distances are given is well inshore.

Thus far the jetties proper have not been materially injured by storms. In a few scattered places the waves have beaten down the peaked crests of rock and at the outer ends of the jetties and occasionally at other places some subsidence of the rock has been noticed, and small rock used for revetment purposes has been scattered and spread by the sea along the steep sandy slopes on the channel side of the jetties, as was expected and desired.

This distribution of small rock has created frequent unfavorable comment and hostile criticism through at least one local newspaper, clippings from which were regularly mailed to Senators and Members of Congress from California, to high officials in the War Department, and to other officers in charge of public works with a view to discredit the work and its management.

A summary of the construction work by months during the past fiscal year may be of interest:

NORTH JETTY.

Months.	Rock.		Trestle.	Mattress.
1894.	*Tons.*	*Lbs.*	*Feet.*	*Cubic feet.*
July	13,657	760	577	3,402
August	21,121	1,750	738	4,572.34
September	24,192	1,500	160.5	4,051.70
October	23,449	1,750	303.5	1,973.20
November	7,852	410	.....	.....
December	9,815	2,230	321	1,780.21
1895.				
January	11,377		.....	23.85
February	.....	.....	.....	.....
March	2,982	1,490	.....	.....
April	25,216	2,000	.....	.....
May	26,755	450	60.4	140.5
June	30,794	1,420	738	3,771
Total for north jetty	197,216	310	2,898.4	19,715.80

SOUTH JETTY.

1894.				
July	3,898	950	.....	.....
August	4,562	100	.....	.....
Total for south jetty	8,460	1,050	.....	.....
Total for fiscal year on both jetties	205,676	1,360	2,898.4	19,715.80

Amount expended during the past fiscal year.—The amount expended during the past fiscal year was $300,244.37, making the total amount thus far expended $876,727.96.

Results obtained.—A survey made in December, 1894, a copy of which is herewith, showed that a few changes had occurred since May. The channel over the bar had shifted slightly to the north and deepened 1 foot, being 25 feet deep and 100 feet wide. The channel by the north spit in the entrance had also a depth of 25 feet. The Bucksport Channel was unchanged. The channel from south jetty to south bay had shoaled considerably. A middle ground 3,600 feet long existed, lying approximately north and south, just inside the shore end of the jetties. This has since been much reduced in extent. The accumulation of sand on the north side of the north jetty continued during the year.

In May, 1895, another survey of the entrance was begun, but was not fully completed in time to be incorporated in this report.

As stated elsewhere, the former dredged channels inside the bay have deteriorated to such an extent that full advantage can not be taken by vessels of the 25-foot channel over the bar, for, although deep-draft ships may enter the harbor they have difficulty in reaching and leaving the wharves in Eureka at the low-tide stages. This matter will be the subject of future report.

Lieut. Herbert Deakyne, Corps of Engineers, has been the resident engineer in local charge of the work during the past year. His report is sent herewith, and contains many interesting details of the work. Acknowledgments are due him for strict attention to duty and valuable services.

Assistant Engineer W. E. Hughes and Inspectors F. Moulton and F. J. Swall were employed during the entire year and Inspectors H. G. Parker and D. L. Larkin for part of the year. All have rendered efficient and faithful service.

Future operations.—The amount of money at present available for the work is $392,177.74. At the present rate of earnings by the contractor this amount will be barely adequate to meet the payments to June 30, 1896.

In addition to the amounts already appropriated $475,000 can be advantageously expended during the fiscal year ending June 30, 1897.

Money statement.

July 1, 1894, balance unexpended		$518,016.41
Amount appropriated by sundry civil act approved March 2, 1895		225,000.00
		743,016.41
June 30, 1895, amount expended during fiscal year		300,244.37
July 1, 1895, balance unexpended		442,772.04
July 1, 1895, outstanding liabilities	$50,594.30	
July 1, 1895, amount covered by uncompleted contracts	392,177.74	
		442,772.04
Amount (estimated) required for completion of existing project		818,115.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		475,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

REPORT OF LIEUT. HERBERT DEAKYNE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., March 6, 1895.

SIR: I have the honor to submit the following report of operations for the improvement of the entrance to Humboldt Bay, California, during the season beginning April, 1894, and ending February, 1895.

At the close of the work for the winter, February 3, 1894, the north jetty had been extended to bent 265, a length of 4,248.6 feet, of which a length of 3,608 feet was completed to full height.

The south jetty had been extended to bent 230, a length of 3,699 feet. During the winter the last two bents of the north jetty trestle, 264 and 265, and one pile in bent 263 were carried away. There was very little settlement of rock during the winter; some of the rock near the outer end of the completed portion was beaten down by the sea.

The trestle of the south jetty had been destroyed during the preceding season as far back as bent 208, distant about 350 feet from the outer end. There were no further injuries of any consequence during the winter.

The work in contemplation for the season of 1894 was the extension of the north jetty, the repair of the trestle of the south jetty, and the protection of this jetty on the channel side by a revetment of rock. The contract of December 16, 1892, with John C. Bull, jr., of Arcate, Cal., was still in force.

During the winter season the contractor had been making repairs and enlargements of his plant. The wharf at Bayside was extended to deeper water, so that rock could be towed away at low tide.

A full barge load (21) of the hydraulic cars invented by Mr. Pine, of Eureka, was procured, and a barge load of old cars was changed to hydraulic cars. The contractor's two locomotives, in addition to receiving a general overhauling, were fitted with pumps for the operation of the hydraulic cars. Preparations were made for the use in the quarry of a jet of water for washing the dirt and waste rock away from the larger rock. A portion of the stream in which the quarry is situated was diverted into a ditch dug along the brow of the hill above the quarry, and was used to supply the jet. Additional derricks and hoisting engines were obtained.

The first work done was the construction of a new wharf and shore tracks on the south spit, the old wharf and tracks being no longer fit for use. The cost of renewing them was estimated at $4,000, but as the contractor preferred to have a wharf in an entirely new location, and a new set of shore tracks to correspond, he was authorized to make such construction as he desired, with the understanding that he should bear all expense in excess of $4,000.

This plan was carried out; he was paid for 1,600 feet of shore track at $2.50 per foot, the material and labor for this track being furnished by the contractor. For the remainder of the track and for the wharf and apron the contractor was allowed to use such old timber, planking, and rails as were serviceable.

During the winter and early spring a few piles under and near the hinge of the apron on the north spit had scoured out. A complete set of new piles under the hinge of the apron and nine piles in the wharf were driven. The grade of the approach to the apron was eased by cutting off the piles in two bents, making the grade about 40 feet long, instead of 15, as before. The shore tracks were cleared of the sand that had drifted on them during the winter. The grade on the trestle of north jetty between the shore end and the beginning of double track was eased by making it longer than before; at the same time the grade was made uniform, it having been very irregular previous to this time.

After the repair of the north spit wharf the pile driver was taken out on the north jetty and proceeded to put the trestle in repair. Seven piles were driven in the vicinity of bent 60, to replace a like number broken out by a drift log a short time before the cessation of work the preceding season. One pile was driven in bent 56 under a projecting cap. One pile in bent 263, lost during the winter, was replaced, and bents 264 and 265 were rebuilt.

Around the end of the jetty a very deep hole was found. The piles of the first bent of new work were driven May 12, in a depth of 32 feet; those of the next bent in a depth of 34 feet.

The water then began to grow shoaler, decreasing to 20 feet in depth at bent 274. The experience here was similar to that met with in October, 1893, when pile driving was resumed after a stoppage of two months, in that the greatest depth was found in building the second bent of new work. In the deep water between bents 265 and 270 it was found that the trestle was very unsteady; accordingly braces were put on the piles. These braces were made of 3 by 12 inch plank, 16 feet long; four were used to a bent, one pair being placed on the north and north center piles. The use of braces was discontinued after the trestle reached a point where the water was only about 20 feet deep.

The first mattress was sunk May 17 in an average depth of 34 feet. Work continued without interruption till the end of June, at which time the trestle extended to bent 323, a length of 5,178 feet; mattresses were sunk to 8 feet beyond bent 311, a length of 4,993 feet; and completed jetty extended to bent 235, a length of 3,767 feet.

A cross-over between the tracks on the trestle at bent 260 was constructed in June at a cost of $284.75.

The first rock of the season was delivered at the south spit April 30, and was used to begin the revetment on the channel side of the jetty. The revetment was made continuous from the spur at bent 150 toward the outer end of the jetty. By the 23d of June it was completed as far as bent 184; work was then suspended until a pile driver could be constructed for the repair of the trestle ahead of bent 184. Up to this time 16,052 tons of rock, principally small rock, had been used for the revetment.

A survey of the entrance was made in May. It showed a marked change since the survey of December, 1893. The depth in the southwest channel over the bar was found to be 24 feet; the northwest channel had partly closed up. The channel close by the north spit had deepened from 10 to 25 feet, so that a continuous channel of 24 feet depth extended from the ocean to a point 2,000 feet above the light-house wharf on the north spit. The channel alongside the outer end of the south jetty shoaled about 10 feet during the winter. The depth in the old Bucksport Channel was found to be 10 feet.

Fifteen new piles were placed in the north spit wharf by the contractor in June. They were in line of the repairs he should have made upon the stoppage of work in February, which repairs were left in abeyance because the question of a relocation of the wharf was under discussion.

A few piles were carried away from the outer end of the south jetty trestle in June. No entire bents were lost.

The rock delivery for the season up to the end of June amounted to 33,769 tons. The earnings for the same period amounted to $62,505.93, making the total on the contract $219,145.15.

At the beginning of the fiscal year 1895 work was in progress on the north jetty. Early in July the work was interrupted by strikes on the part of the laborers. The pile-driver crew quit work on June 30 and did not return. On the 2d of July a strike occurred at the quarry, putting a stop to all rock work. A new pile-driver crew was secured for the north jetty and a compromise was effected with the quarry laborers. Pile driving was resumed July 7 and rock delivery on the 11th.

The depth of water in which the piles were driven was very uniform during July. It varied but little from 10 feet. Deeper water was encountered in August, the maximum being a little over 16 feet. By the 21st of September the pile driver had reached bent 423.

A period of stormy weather in the latter part of September and early part of October made the progress of the work very slow.

Bent 423 was partially destroyed September 22; it was rebuilt on the 25th, and was again destroyed on the 26th; it was rebuilt October 9, and the pile driving was carried as far as bent 431 by October 15. The next day a high tide and heavy sea occurred together, and the outer eight bents of trestle were carried away, leaving 423 the last bent standing; about a week later it was carried away.

It was rebuilt again November 5, and by the 9th the trestle had been rebuilt to bent 425. It was then decided to put additional fastenings on such additional trestle as might be constructed during the season. Each pile was to have fitted to its top a ring of 2 by $\frac{1}{2}$ inch wrought iron, to prevent splitting of the head of the pile during storms; each pile was to be fastened to the cap with three 1-inch steel drift bolts; the stringers were to be fastened to the caps by 1-inch wrought iron screw bolts with head and nut; the straps previously used to fasten the caps down on the piles were to be lengthened 6 inches on each leg; so as to take eight spikes instead of six, as formerly; and pieces of 2-inch pine plank were to be spiked under the stringers, fitting snugly between caps, and on the top of caps between stringers, and outside of outer stringers. This method was to be applied to the trestle beginning with bent 426. Bents 426 and 427 were driven on November 11 and 12, respectively. The rings were put on the heads of the piles; part of the steel drift bolts and all of the iron screw bolts were put in. Only one strap had been placed in the two bents, and no planking had been put on. While the trestle was still in this incomplete condition a storm came on and destroyed these two bents and bents 424 and 425. It was then decided to make no further attempt to extend the trestle during the season. Bents 418 to 423, inclusive, were strengthened with extra steel drift bolts and iron screw bolts. The trestle then stood until the severe storm in the early part of January. A number of piles were broken out on the 11th and 12th, and on the 13th a gap of thirty bents, from bent 388 to bent 417, inclusive, was made. Bents 418 to 423, the six bents that had been strengthened, were left standing, the only damage sustained by them being the loss of one pile in bent 421. These six bents stood without further injury until February 13, when they were totally destroyed. In January and the early part of February the outer ten bents then standing, 376 to 385, were strengthened with extra bolts. These bents are still standing, according to the latest reports from Humboldt Bay.

The scour around the piles before mattresses were sunk was unusually small during the season. At the end of June the depth at which the piles were driven was less than 10 feet, and a deposit of sand was occurring after the driving of the piles,

still further reducing the depth. In order to avoid building the jetty in such shoal water, the plan was adopted of building up the outer end rapidly, with the hope of inducing scour just ahead of the mattress work. This had the desired effect. Very little of the jetty was built in less than 10 feet of water. The average depth in which piles were driven from June 30 to the end of the season was 11.7 feet; during the same period the mattresses were sunk in an average depth of 13.7 feet. For the whole season the corresponding figures are 13.6 and 14.8 feet. The greatest scour after pile driving occurred at bent 415, where the mattresses were sunk twenty-four days after the piles were driven; the scour was 8 feet.

Mattress work was carried as far as bent 425. A mattress was made on bents 426 and 427, November 20, but it broke up and was completely lost before being sunk.

The spur built in August, 1893, at bent 92, north jetty, was found to settle so much as to require replenishing with rock every few months. This spur was not long enough to protect any considerable length of jetty. The continuance of scour in that vicinity rendered it advisable to construct a larger spur, leaving the main jetty at bent 75, and reaching out to a point about 150 feet from the center of the jetty The construction of this spur was begun in September. The trestle was built of three-pile bents, on which was laid a single-track railway, leaving the east track of the main trestle on a curve of 118 feet radius, extending on that curve till an angle of 60° with the main jetty was made, thence on a straight line at that angle. The length of the trestle was 212 feet. The outer half of the spur was built in a depth of 30 feet; the piles in this portion of the spur were driven to a penetration of 20 feet or more. The spur proper was built up of alternate layers of brush and rock to about the height of low water; above that level it was built of rock alone. When the spur was completed the rock in the first five bents was up to about high water; the rock in the next seven bents sloped down to about mid tide; at the last bent the rock was about 20 feet below zero. As the spur was built up, scour took place off the outer end; finally a depth of 72 feet was scoured at a point about 100 feet southeast of the outer end of the trestle. Another immediate effect of the spur was a shoaling over the area to the southward of the spur. The 30-foot contour, which was 50 feet from the center of the jetty opposite bent 100 August 4, was found to be 250 feet from the jetty opposite the same bent October 4. This effect was not permanent, however; in December it was found that the 30-foot contour was close to the jetty again.

Besides the scour off the outer end of the spur, there was also some scour along the north side of the spur; later on scour took place along the south side of the spur. The spur deflected the ebb current very decidedly, but there was an eddy formed to the southward of the spur, so that when a strong ebb current was flowing, a brisk current flowing northward close to the jetty could be observed along bents 80 and 90. On the afternoon of January 11, during a very strong ebb tide, the outer five bents of this spur trestle were carried away. From soundings taken on the 14th it was concluded the pressure of the current against the north face of the spur had forced the upper part of the rock and brush work over to the southward into the hole scoured by the current as it eddied round the end of the spur. The rock in the first eight bents then averaged 2 or 3 feet above zero, the next four bents 17 feet below zero. Of the eight bents left standing, the outer portion was considerably distorted when the last five bents gave way. The trestle was put in order as far as bent 6, and rock was dumped out to that point during the latter part of January, bringing the rock up approximately to a gradual slope from high water at the inner end to 20 feet below low water at the outer end.

In July scour was found to be going on at the North Spit Wharf; it became necessary to put in three piles, which was done with a water jet. On the 2d of August 18 cars of rock were dumped on the north side of the lumber-wharf track to prevent further cutting. This was mattress rock, averaging probably 30 pounds per piece; it was dumped right on the sand without any mattress work at all. The rock did not settle materially; it stopped the cutting and caused some accumulation of sand. Three more cars were placed here October 4, and 10 more January 29.

During the summer it was noticed that the high-water line near the shore end of the north jetty on the bay side was cutting away. The cutting was especially rapid during spring tides, if the sea happened to be at all rough. At the time of the survey of May, 1894, the high-water line of the bay shore reached the jetty at bent 22. As it receded toward the initial point, rock was dumped on the bay side to prevent the trestle being undermined. By the middle of October the cutting had reached bent 8, and it was thought best to put in some shore protection. Accordingly 24 yards of brush and 4 cars of small rock were placed opposite bent 8, making a piece of shore protection just below the high-water line, reaching out some 50 feet from the trestle. This rock proved too light; the swell scattered it and the brush, and the cutting continued. Systematic shore protection was necessary, and October 26 a track was begun, leaving the main jetty at bent 7, and reaching to the wharf. From this track protection work was built of brush weighted with heavy rock. This work put a

stop to the encroachment. The shore line under the wharf still remained unprotected; it was found necessary to place rock and brush under the wharf, thus making the shore protection continuous from bent 7, main jetty, to the north side of the lumber-wharf track, connecting there with the rock dumped in August. The material used for shore protection was 183 yards of brush and 674 tons of rock; the track built for this work was 289 feet long. For revetting from bent 8 to bent 22, 736 tons of rock were used.

In November the construction of a spur at bent 207, north jetty, was begun. This spur was to protect a portion of the jetty that was founded in very shoal water. The average depth under the mattresses from bent 116 to bent 209 was only 6 feet. The trestle for this spur was similar in all respects to the main jetty trestle. The outer three bents of piles were driven 20 feet, the other piles in the spur 15 feet. The depth of water found along the greater part of the spur was 17 feet. Only one layer of mattress work was used. The spur was built up to about low water as far as bent 13; from that point to the outer end, bent 23, it sloped down to 13 feet below zero. The spur was built on a curve of 125 feet radius until a direction perpendicular to the jetty was reached, thence on the perpendicular; the outer bent of trestle was 306 feet distant from the center line of the main jetty. Soundings over the area likely to be affected by the spur were taken; also observations of the directions and velocities of flood and ebb currents in the vicinity. The immediate effect of the spur was to cause scour along the main jetty about bent 200. This was met by a revetment of 918 tons of rock. The outer five bents and the next five alternate bents of the spur trestle were strengthened with extra screw bolts and drift bolts in January.

A cross over between the two tracks of the north jetty trestle at bent 357 was constructed in August at a cost of $285.25. On the 27th of November the trestle of the north jetty in the vicinity of bent 85 settled under the east track upon the passage of a train of rock. The settlement amounted to several inches in the worst place. This portion of the jetty was built under the former contract; the mattresses were sunk in a depth of about 11 feet; the penetration of the piles is not known. There had been a recent scour in that locality undermining the jetty. The trestle was put in order by the driving of nine piles by the contractor. Two of the old piles had been broken off by the settlement; one of them had been completely ruined by teredo and the other had been weakened about one-fourth. As soon as the trestle was put in order rock was dumped off the side of the trestle to form a revetment along the jetty. A considerable revetment was made from bent 80 to bent 111; from bent 112 to bent 145 a slight revetment was made as a protection against future scour. The total amount of rock used for revetting from bent 80 to bent 145 was 6,421 tons.

All the trestle of the north jetty constructed during the year is practically level; the top of the cap was kept about 24 feet above zero.

At the beginning of the fiscal year the only work being done on the south jetty was the construction of a pile driver for the repair of the trestle. The pile driver was ready July 5, on which date the work of driving piles in the trestle began. The old piles standing had been examined as far as bent 190 and certain ones had been noted as being too badly eaten by teredo to be safe for further use. New piles were driven in place of these. Beyond bent 190 it had not been practicable to examine the piles for teredo, so their strength was tested as follows: Each pile was subjected to a horizontal pull of at least 4,000 pounds, applied by the pile-driver engine pulling on ropes attached to the head of the pile. The strength of the ropes had been tested, so that the pull necessary to break them was known.

If the pile was below the required strength, it broke under the pull; if above, the ropes broke. The ropes were made fast at the upper end of the pile, giving a leverage of about 25 feet about the point where the pile entered the rock. A pile acting simply as a vertical pillar requires but a small fraction of its original strength in order to sustain an ordinary load; the chief danger from a weakened pile in a structure such as this jetty is that it may break when struck laterally by a sea or when swayed by a moving load. Out of thirty-one old piles tested only two were found to be below the required strength.

The work of driving piles through rock proved feasible, though difficult. The penetration secured varied from 6 to 18 feet; the average was about 13 feet.

The piles were usually sharpened before driving; on a few piles wrought-iron shoes were tried, but they did not appear to make the driving easier. The trestle standing as far as bent 208 was put in order, a double track was laid from bent 175 outward, and new trestle was built from bent 208 to bent 216. Along all this trestle rock was dumped to revet the slope on the channel side. The work was completed August 16, and operations on the south jetty were discontinued.

During the fall I considered the question of strengthening the outer end of the south jetty trestle against the winter storms. The storm of the latter part of September did some little damage to the trestle; the most noticeable fact, however, was that the injuries extended forty bents back from the outer end. It did not appear

that strengthening the outer end would be of any use, so the plan was abandoned. During the stormy period in the latter half of October thirty-one bents of the trestle were carried away.

The outer end remained intact until after a large gap had been made from fifteen to twenty-five bents back from the end, then the outer end was swept away. The trestle was injured more or less by the several periods of rough weather during the fall and winter.

At the close of the season February 8, 1895, the trestle was standing as far as bent 165, with eight piles broken out between that point and bent 154.

The rock placed as revetment on the channel side of the south jetty was beaten down and flattened out by the sea so that its crest at the end of the season was probably 5 or 6 feet lower than when the revetment was completed. The destruction of the trestle along almost all the part where the revetment was made prevented soundings being taken at the end of the season. The last soundings on this rock were obtained about the end of September. The revetment in bents 150 to 184 had then been in place about four months; from bent 185 to bent 216 the rock had been in place about two months. The crest of the revetment was flattened out nearly level; below the crest the rock on the older portion had a slope of about two-thirds and on the newer portion a slope of four-fifths.

A survey made in December, 1894, showed that but little change had occurred since May, 1894. There had been a little deepening of the channel over the bar, and its position had shifted very slightly to the northward. A channel of 25 feet depth existed on the bar, having a width of 500 feet at its narrowest part. The channel by the North Spit had also a depth of 25 feet, and a continuous channel of 25 feet depth extended from the sea to a point about 1,800 feet above the light-house wharf on the North Spit. In Bucksport Channel a depth of 10 feet was found. The channel leading from the end of south jetty to South Bay had shoaled considerably during the year.

Opposite bent 100 south jetty a depth of barely 24 feet existed.

A longitudinal section and cross sections at every tenth bent of north jetty were taken just before the close of the work.

Intermediate cross sections were taken at important places near the spurs and along the sharp curve of north jetty.

Longitudinal and cross sections were also taken of the two spurs at bents 75 and 207.

At the end of the season the wharf at the North Spit was put in repair. An extension to the wharf was constructed to facilitate landing barges. The contractor drove twenty-five piles in the wharf at his own expense. They made good all deterioration that had occurred during the working season. Eighteen piles were driven in the wharf at Government expense to place the wharf in better condition than for some time past. The system of shore tracks was entirely remodeled, so as to give gentler curves and grades. The scales platform was raised 1 foot. At the same time it was lengthened 4 feet, so that three cars can now be weighed instead of two as formerly. A few of the piles in the wharf were put down with a water jet. The penetration obtained varied from 5 to 14 feet, the average being about 10 feet.

One pile put down about 14 feet February 4 came up 1 foot during the following night, and the next morning it came up about 10 feet more. It was put down again, and was sawed off and made fast under a cap before it had a chance to rise again. No satisfactory explanation for this behavior of this pile has been reached.

The wharf extension is 114 feet long and 32 feet wide; its cost was $1,262.38. The repairs to the old wharf, the changes in scales, and the relocation of shore tracks cost altogether $685.32.

At the close of the work for the season, February 8, 1895, the trestle of the north jetty was intact as far as bent 385; one pile was standing in bent 387, and the six bents 418 to 423 inclusive were standing intact, with the exception of one pile in bent 421. Mattress work extended 40 feet beyond bent 423, a length of 6,820 feet, and completed jetty extended to bent 341, a length of 5,466 feet.

For purposes of accurate sounding near the line of the jetties Mr. Hughes constructed two cantilever trusses of wood and wire, and mounted one on the hand car on the south jetty and the other on a small car on north jetty formerly used as a water car. By means of these cars and trusses soundings can be taken with great accuracy to a point 70 feet from the center line of the jetty. They are especially useful in finding the slope taken by rock, getting cross sections of the jetties, and watching scour near the jetties. The cost of the apparatus for the south jetty was $10; for the north jetty, $16.

The hydraulic cars invented by Mr. Pine, of Eureka, gave some trouble at the beginning of the season, but after a little modification they were operated successfully. The hose at first used proved too weak to stand the pressure necessary with the size of ram used. Stronger hose was obtained. Even then the cars required careful attention, but for handling large rock they were shown to be a marked improvement over the old-style cars.

The following table shows the monthly rock delivery, the most important item of the season's work:

Months.	North jetty.		South jetty.		Total.	
1894.	*Tons.*	*Lbs.*	*Tons.*	*Lbs.*	*Tons.*	*Lbs.*
April	.....	.....	214	2,130	214	2,130
May	5,489	1,490	9,425	220	14,914	1,710
June	12,227	1,350	6,411	1,800	18,639	910
July	13,657	760	3,898	950	17,555	1,710
August	21,121	1,750	4,562	100	25,683	1,850
September	24,192	1,500	.....	.....	24,192	1,500
October	23,549	1,750	.....	.....	23,549	1,750
November	7,852	410	.....	.....	7,852	410
December	9,815	2,230	.....	.....	9,815	2,239
1895.						
January	11,377	2,180	.....	.....	11,377	2,180
Total	129,284	2,220	24,512	720	153,797	700

The rock consisted of 52,363$\frac{280}{2240}$ tons of large and 101,434$\frac{420}{2240}$ tons of small rock. The total earnings for the season were $268,354.61.

The rejections of rock for the season amounted to about 4,500 tons, or 3 per cent of the total delivery. The rejections were made for both the quality and the size of the rock.

They were especially heavy during June and July. The rock rejected for quality was chiefly of four kinds—a fine-grained blue rock, full of thin seams, some of it so soft as to be crumbled in the hand; a surface rock of a yellowish-gray color, having an appearance of partial disintegration; a soft conglomerate, crumbling on slight pressure, and a rock containing seams of slate. Specimens of all these kinds of rock had been observed in process of disintegration in the work.

In June 75 tons of rock, consisting of 48 tons of accepted rock and 27 tons of rejected rock, was dumped along the shore track on the North Spit as samples of the rock then being received.

The accepted and rejected rock of this lot was separated and piled in different heaps.

In July and August an examination was made of the rock visible in the jetties at low water with a view to ascertaining whether or not signs of disintegration could be found. In the north jetty from the shore end to bent 220 signs of disintegration were found in 52 tons. Of the total amount of rock examined in the two jetties the amount found disintegrating was about 1 per cent.

In the shore protection work built on the South Spit in 1889 about 50 per cent of the rock visible contained signs of disintegration.

A noticeable fact disclosed by the examination was that very little disintegrating rock was found below the level of mean high tide, and none whatever below half tide.

As it is impracticable to make a careful examination of the rock that is permanently under water in the jetties, the following test was inaugurated in accordance with your orders: Specimens of rock were taken from the cars as they arrived at the North Spit, the locality in the quarry from which each load came having been previously noted. These specimens included every known variety of rock, good and bad, then being received from the quarry.

In all, sixty specimens were obtained; of each specimen three test pieces were made. They were baked to drive off the moisture and then carefully weighed to the nearest dram. One piece of each specimen was then exposed to air, one in sea water, and the third alternately twelve hours in air and twelve hours in sea water. The sea water for the second and third tests is renewed once a week. These pieces were exposed for the test August 31, 1894. The test is still in progress.

The greater part of the jetty constructed during the year was built in from 10 to 15 feet of water. The following figures of cost in different depths have been compiled from the records. The average of six bents in each depth has been taken.

Bents.	Depth under mat.	Small rock.	Large rock.	Thickness of mat.	Cost of bent complete.	Cost per foot of jetty.
	Feet.	*Tons.*	*Tons.*	*Feet.*		
290 to 295	15.9	439	347	3.4	$1,317.65	$82.35
338 to 343	10.6	218	333	3.4	994.82	62.18

The work of the contractor during the year was under the efficient management of Mr. W. E. Dennison.

Mr. D. E. Hughes was employed as assistant engineer on the work during the year; the inspectors were Messrs. Frank J. Swall and Floyd Moulton for the whole season, and Messrs. H. G. Parker and David L. Larkin for short periods. All deserve commendation for good service.

Very respectfully, your obedient servant,

HERBERT DEAKYNE,
Second Lieutenant, Corps of Engineers.

Maj. W. H. HEUER,
Corps of Engineers.

STATISTICS OF TRADE.

The following complete statistics of trade of Humboldt Bay for the year from June 1, 1894, to May 31, 1895, were collected and furnished by the Humboldt Chamber of Commerce, Eureka, Cal.

Movement of vessels.

	Steam.	Sail.	Tonnage.
Arrivals	284	247	144,397
Clearances	263	227	145,246
Total crossing bar	547	474	289,643

Passenger movement.

Arrivals per steamers	5,760
Departures per steamers	5,501
Total crossing bar	11,261

Foreign lumber cargoes.

Destination.	Cargoes.	Feet, B. M.	Value.
Hawaiian Islands	9	3,077,116	$50,040.32
Australia	6	2,782,010	50,520.10
Central America	3	654,060	10,623.95
Mexico	2	542,049	5,263.61
Peru	1	357,870	6,468.81
Total	21	7,413,105	122,916.79

Classified freights.

	Tons.		Tons.
Lumber and its products	178,749	Fruit (green, dried, and canned)	505
Butter	846	Fish	133
Cheese (new product)	59	Cattle, hogs, sheep, and dressed meats	1,301
Wool	375	Miscellaneous	1,658
Hides, tallow, bones, etc	116		
Leather	180	Total	185,594
Oats	450		
Produce	1,222		

Vessels employed in Humboldt trade.

Sailing vessels	63
Steamers	21

NOTE.—The apparent falling off of the shipments of butter, oats, and produce, as compared with those for last year, is due to the fact that the statement furnished you last year included the amounts of these items shipped from Port Kenyon, over Eel River Bar, direct to San Francisco. The shipments of butter direct from Port Kenyon since May 1, 1894, have amounted to 898 tons, making the total shipments from the county for the year ending June 1, 1895, 1,744 tons, the largest since the commencement of the industry.

PACIFIC OCEAN

North Spit

South Spit

Red Bluff

E L K R I V E R

Reference

Represents Jetties actually constructed

" Proposed Extensions

Soundings are in feet reduced to low Water

OFFICIAL

W. H. Heuer

Major of Engineers

Scale of Feet

ENTRANCE TO
HUMBOLDT BAY, CAL.

Survey of Dec. 1894.

Made under the direction of

Lieut. Herbert Deakyne Corps of Engineers U.S.A.

By D.E. Hughes Assistant Engineer

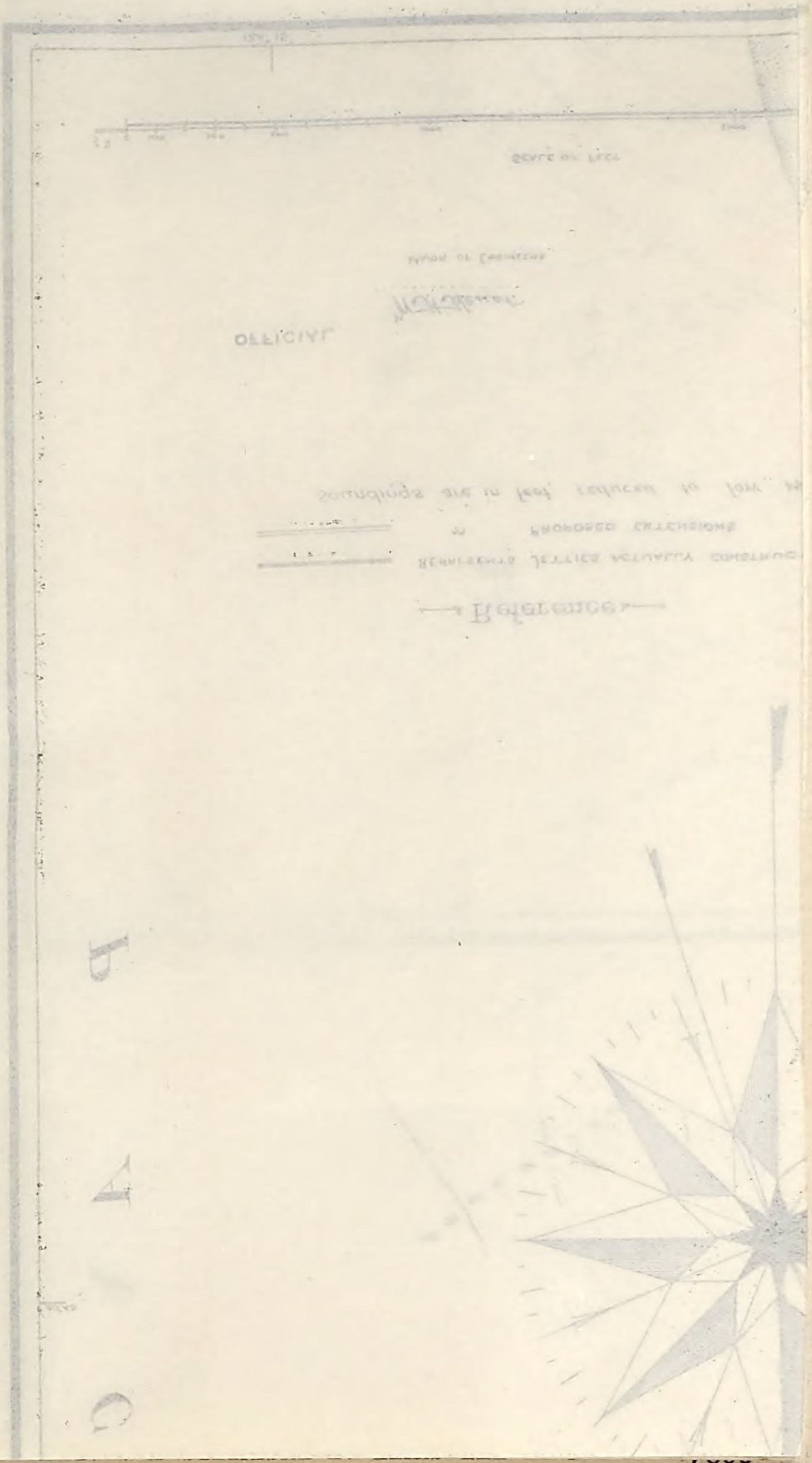
Scale 1-600

Major W. H. Heuer

Corps of Engineers U.S.A. in charge

Forwarded with annual report of Major W. H. Heuer Corps of Engineers, for the fiscal year ending June 30 1895

Eng 54 1



The excess of tonnage sailing over that arriving is explained by the fact that at the commencement of the year figured the tonnage in port was 4,022, and at the close 3,129.

The following statement of the freight carried by the steamer *Humboldt* between Eureka and San Francisco was furnished by the agent of the steamer:

	Tons.		Tons.
Lumber products	2,382	Leather and hides	44
Butter	905	Live stock	35
Wool	160	Miscellaneous	670
Produce	180		
Fish	105	Total	4,65
Oats	171		

The following statement of the freight and passengers carried on the steamer *North Fork* between Eureka and San Francisco was furnished by Capt. Charles Nelson, the agent of the steamer:

	Tons.
General merchandise from San Francisco	4,370
General merchandise to San Francisco	543
Lumber to San Francisco	21,285
Total	26,212

Passengers.

From San Francisco	388
To San Francisco	563

The following statement of the freight, treasure, and passengers received and delivered at Humboldt Bay from June 1, 1894, to May 31, 1895, by the steamers of the Pacific Coast Steamship Company was supplied by Messrs. Goodall, Perkins & Co., the general agents of the company:

Received at Humboldt Bay:		Delivered at Humboldt Bay:	
Freight ..... tons	12,045	Freight ..... tons	4,660
Treasure	$159,990	Treasure	$237,445
Passengers	2,929	Passengers	3,160

S S 6.

PRELIMINARY EXAMINATION OF FEATHER RIVER, CALIFORNIA, ABOVE MARYSVILLE.

[Printed in House Ex. Doc. No. 53, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 1, 1894.

SIR: I have the honor to submit the accompanying copy of report, dated October 12, 1894, by Maj. W. H. Heuer, Corps of Engineers, giving results of preliminary examination of Feather River, California, above Marysville, provided for by river and harbor act of August 17, 1894.

Major Heuer reports that he considers that there is no public necessity for the improvement of the Feather River above Marysville, and this opinion is concurred in by the division engineer, Col. George H. Mendell, Corps of Engineers, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., October 12, 1894.

GENERAL: In accordance with the river and harbor act of August 17, 1894, and circular letter from the office of the Chief of Engineers, dated August 20, 1894, an examination of "the Feather River, California, above Marysville" was made by me on October 8, 1894, and the following is the report of said examination:

The Feather River rises in the Sierra Nevada Mountains and flows in a general southerly direction to the Sacramento River, which it joins at a point about 21 miles above the city of Sacramento. This river, in early days, and as late as 1861, has been occasionally navigated by very light-draft steamboats as far as Oroville, which is about 66 miles above the mouth of the river. Since that date Yuba City, situated on the left bank and about 30 miles above the mouth of the stream, has been considered as the head of navigation of this river. Occasionally a little steamboat drawing about 1 foot of water, and towing a flat-boat 18 feet wide and about 40 feet in length, brings down to Yuba City a load of fruit from a ranch situated about 15 miles above. At Oroville the Feather River is said by the State engineer, in his report of 1880, to be 160.5 feet in elevation above the level of low tide in Suisun Bay, and to have a fall from Oroville to its mouth, a distance of 66 miles, of about 65 feet, an average of about 1 foot fall per mile. He gives the low-water discharge of the stream above Yuba City as 1,200 cubic feet per second, the high-water discharge at 12,000 cubic feet per second, and the average low-water width of channel at 280 feet.

The examination was made by me on October 8, 1894, in a gasoline launch, drawing about 30 inches of water, and extended from the mouth of the Yuba River, which enters the Feather at Marysville and opposite Yuba City, to a point said to be by river 10 miles above Marysville, at the site formerly occupied by the reform school. At this point the launch ran aground and could go no farther, though it is possible that a few miles more could have been navigated in a skiff. In this 10 miles of river the Feather is quite clear, its banks are from 5 to 15 feet in height, densely covered with brush, willows, and cottonwoods, its bottom is sand, and here and there on the sides a sand bar is visible. There are very few snags in the river, and none that are really any obstacle to navigation; moreover, in this distance there are no sharp bends, overhanging trees, or water shoal enough to interfere with navigation. The present stage of the river is a little less than 1 foot above its extreme low-water stage; in freshets its rise is said to be about 18 feet in vertical height, and on these occasions the whole country is inundated, which explains why there are no farms adjacent to either bank of the river. Connecting Marysville with Yuba City is a covered wagon truss bridge without a draw. The bottom chord of this bridge is about 22 feet more or less above low-water stage of the river. About 200 yards above this bridge is another trussed bridge, over which the railroad crosses the river. Some 2 miles above this second bridge is a third bridge, used by the railroad in going from California to Oregon. Not one of these bridges has a draw, and the bottom chord of each bridge is from 20 to 25 feet above the level of low-water stage of the river.

In the 10 miles, more or less, of river examined the most striking feature was the clearness and depth of the water as compared with that portion of the river below the junction of the Yuba. The current

just above the Yuba junction was sluggish and apparently gradually increased in the next 10 miles above until it reached a velocity estimated at from 1½ to 2 miles per hour. When the launch ran aground and could go no farther, the depth of water was from 26 to 30 inches and the bottom was a mixture of sand and mud, into which the sounding pole easily penetrated to a depth of 8 feet.

This clear and moderately deep pool is accounted for by the fact that the Yuba moves annually an immense quantity of sand and other fine mining detritus. This is lodged, some of it in the Yuba, but much of it in the Feather. At the junction of the two rivers the bed of the Feather has been raised at least 13 feet, probably more. This has caused a submerged dam and backed up the Feather.

On the return trip down the river the launch was run very slowly in the channel at as uniform a rate of speed as was practicable. At every sixtieth second a sounding with a pole was carefully made, and the following is the result. Depths are expressed in feet, and where x is shown it means that the depth was greater than 12 feet, which was the length of the pole: 5, 6, 5, 6, 4, 6, 7, 9, 6, 10, 6, 5, 6, 4, 7, 8, 7, 8, 9, 8, 8½, 5, 8, 6, 5, 4, 5½, 6, 8, 7, 10, 8, 10, 7, 7½, 7, 10, x, x, x, 9, 9, x, 9, 6½, 8, x, 10, 6, 10, 9½, x, x, 7, 6½, 6, x, x, x, x, x, 8, 8, 11, 8, 8, 8, 9, x, x, x, x, x, x, x, x, x.

Over the stretch of river examined there is practically no commerce and no farms on either bank. A railroad runs on each side of the river. One goes to Oroville, 26 miles above Marysville, the other to Oregon; both join near Marysville. Neither of these railroads for over 30 miles of length of river is over 10 miles from the river, and the average distance between railroad and river is less than 5 miles.

Navigation on the 10 miles of river above Marysville is practicable at all seasons of the year, and this stretch of river is in far better boating condition than is the 30 miles of Feather River below Yuba City, to which place, at lowest water periods, not over 2 feet depth of water can be found. The only obstacles that could possibly interfere with navigation for 10 miles on the Feather River above Marysville would be the absence of draws in the three bridges referred to. At high and medium stages of the river boats could not pass under these bridges. At low water there is not depth of water enough in the river beyond a point 10 miles above Marysville for navigation, and not enough commerce in sight to warrant an improvement in this upper river.

Under these circumstances, namely, bad river below, no navigation when the conditions for navigation are favorable, and practically no commerce above Marysville, I consider that there is no public necessity for the improvement of the Feather River above Marysville.

Respectfully submitted,

W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY.
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., October 24, 1894.

Respectfully forwarded.

The statutes of California declare the mouth of the Yuba (that is, Marysville) to be the head of navigation of the Feather River. This fact accounts for the absence of draws in the bridges herein mentioned.

For reasons stated in this report, the opinion therein expressed that there is no public necessity for the improvement of Feather River above Marysville is concurred in.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

S S 7.

PRELIMINARY EXAMINATION OF GEORGIANA RIVER, CALIFORNIA.

[Printed in House Ex. Doc. No. 72, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 4, 1894.

SIR: I have the honor to submit the accompanying copy of report of November 26, 1894, by Maj. W. H. Heuer, Corps of Engineers, upon preliminary examination of Georgiana River, California, made to comply with requirements of the river and harbor act of August 17, 1894.

For the reasons given, it is the opinion of Major Heuer, and of the division engineer, Col. G. H. Mendell, Corps of Engineers, that this stream is worthy of improvement to the extent of removing snags and overhanging trees which obstruct navigation.

I concur in the opinion expressed by these officers.

It is reported that no survey of the river is necessary.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., November 26, 1894.

GENERAL: In accordance with the river and harbor act of August 17, 1894, and circular letter from the Office of the Chief of Engineers, dated August 20, 1894, an examination of Georgiana River, California, was made by First Lieut. Graham D. Fitch, Corps of Engineers, under my orders, on November 11, 1894, and I have the honor to transmit herewith his report.

In my opinion, for reasons stated by Lieutenant Fitch, Georgiana River, which is invariably known as Georgiana Slough, carries commerce enough to make it worthy of improvement to the extent of removing snags and overhanging trees which obstruct navigation. * * * No survey is necessary.

Respectfully submitted.

W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., November 27, 1894.

Respectfully forwarded to the Chief of Engineers.

For reasons stated in the report of First Lieut. Graham D. Fitch, Georgiana River, or Slough, is considered to be worthy of improvement to the extent of removing snags and overhanging trees which obstruct navigation.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF FIRST LIEUT. GRAHAM D. FITCH, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., November 23, 1894.

MAJOR: I have the honor to submit the following report upon an examination of Georgiana Slough made by me in a skiff on November 11, 1894:

Georgiana Slough is a branch of the Sacramento River connecting it with the Mokelumne River. It leaves the Sacramento River at Walnut Grove, about 6 miles below the head of Steamboat Slough, flows in a general southwesterly direction, and empties into the Mokelumne River near the junction of the north and south forks of that stream. The Mokelumne, a few miles below, empties into the San Joaquin about 20 miles above its mouth. The distance by water between Stockton or other points on the San Joaquin above the mouth of the Mokelumne and Sacramento, or other points on the Sacramento River above Walnut Grove, is, therefore, very materially shortened by the existence of Georgiana Slough. The slough is about 12 miles in length. It is between 120 and 150 feet wide for the most part, occasionally for short distances about 250 feet wide, a width permanently maintained for the last few miles above its mouth. It is of ample depth throughout for navigation. I took occasional soundings and found no depth less than 15 feet.

The banks are perpendicular, of stiff clay, overgrown with brush except at the lower end, and they gradually diminish in height from about 12 feet at the head to about 4 feet at the mouth. Both banks are leveed throughout. The bottom consists of clay, peat, and sand. Andrus Island and Tyler Island are separated by the slough. The former island lies between the Sacramento River and Georgiana Slough, the latter between the north fork of the Mokelumne and Georgiana Slough. Both of these islands, particularly along the bank, are in a high state of cultivation, the main products being fruit, beans, potatoes, barley, and alfalfa. The lower end of Tyler Island has only been under cultivation for a short time, and the interior of the island still consists largely of tule swamps, which probably will be reclaimed before many years. The only obstructions to navigation are snags and overhanging trees, and not many of them; nevertheless it is necessary for steamers entering the slough to drag a chain and drop downstream stern first in order to avoid collision with them. I estimate that the United States snag boat *Seizer* can do all the work necessary to be done in Georgiana Slough in about two weeks' time. * * *

The following steamers, owned and operated by the California Transportation Company, have navigated in Georgiana Slough, and have made regular trips from January 1 to November 20, 1894, as follows:

Name of steamer.	Gross tonnage.	Trips.
Constance	492.75	101 regular.
Aurora	406.32	64 regular.
Sonoma	306.62	50 regular.
Alvira	469.69	17 special.

Merchandise, fruit, and produce carried, 11,600 tons

The average freight rates charged are, for fruit $1.75 per ton, and for vegetables $1.125 per ton to San Francisco. The rates by water are about $1 per ton cheaper than by rail, and a 16-mile haul is avoided.

In my opinion Georgiana Slough is worthy of improvement to the extent of removing such snags and overhanging trees as at present obstruct navigation.

Very respectfully, you obedient servant,

GRAHAM D. FITCH,
First Lieutenant, Corps of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S S 8.

PRELIMINARY EXAMINATION OF MENDOCINO HARBOR, CALIFORNIA.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 28, 1895.

GENERAL: In compliance with your instructions of August 20, 1894, I have to submit the following report of a preliminary examination of Mendocino Harbor, California, directed by section 10 of the river and harbor act of August 17, 1894:

The examination was made by Lieut. H. Deakyne, Corps of Engineers, during this month, and his detailed report thereof is herewith.

I also am familiar with the locality from having been on the ground and from numerous trips on coasting vessels passing close inshore near Mendocino Bay.

The few favorable features for making any improvement in Mendocino Bay are its geographical position, being situated nearly midway between San Francisco and Humboldt bays, about 110 to 120 miles from either port, its size as compared with other open roadsteads in Mendocino County, the development of an increased trade in the section of country tributary to the bay, and the probable reduction of rates of freight and insurance.

The unfavorable features which operate against the improvement of the harbor are, first, the cost of any radical improvement so as to make a harbor of refuge at the locality, and secondly, the small area of harbor room that would be available for anchorage in case such harbor were ever made. For the local trade of the country the harbor is ample and safe during the prevalence of northwest winds, which obtain during seven to nine months of the year. During the stormy months of the winter against strong westerly and southwesterly winds the harbor can not be considered safe, and to make it so would require the construction of two breakwaters, one from each side of the entrance approaching each other, aggregating about five-eighths of a mile in length, and with an opening of about 700 feet wide between them. They would have to be built in water averaging over 4 fathoms in depth, requiring over a half million tons of rock, of which there is none suitable in sight, and would cost probably $1,000,000. Assuming this work built, there would then be within the harbor a protected area of not over 80 acres against westerly and southwesterly gales. There is certainly not commerce enough at present or in prospect in this locality to warrant the expenditure of this amount of money for building a harbor here, and if the commerce were increased fivefold the possible saving in freight would not equal the interest on the cost of construction of a work of this magnitude, to say nothing of the small harbor area that would result after the work was completed.

For reasons stated, I am of opinion that the advantages to be derived from the construction of a harbor at Mendocino Bay are incommensu-

rate with the expense involved, and that at present Mendocino Harbor, California, is unworthy of improvement by the Government.

Respectfully submitted.

W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. G. H. Mendell, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., March 1, 1895.

Respectfully forwarded to the Chief of Engineers.

For reasons herein stated, I concur in the opinion that Mendocino Harbor is not worthy of improvement by the General Government.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF LIEUT. HERBERT DEAKYNE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., February 25, 1895.

SIR: I have the honor to submit the following report of a preliminary examination of Mendocino Bay, California, made in accordance with your instructions:

I left San Francisco on the steamer *Point Arena* February 16 and reached Mendocino City, situated on Mendocino Bay, the next day.

For my information in regard to the bay and vicinity I am indebted largely to several residents of Mendocino City, viz: Mr. J. C. Ford, superintendent of the Mendocino Lumber Company's mill; Mr. Albert Brown, bookkeeper for the same company; Mr. William Heeser, secretary of the Mendocino Discount Bank and of the Mutual Savings Bank of Mendocino; Captain Johnson, of the steamer *Point Arena;* Mr. G. Canning Smith, attorney at law, and several other business men of the locality. For the hydrography I have consulted the publications of the U. S. Coast and Geodetic Survey. Statistics of trade were furnished by the Mendocino Lumber Company, Mr. E. C. Williams, president.

Mendocino Bay is an oblong body of water, about 1 mile in length and one-half mile in width, the longer dimension being approximately in the meridian. The bay is bounded on the north, east, and south sides by high rocky cliffs. On the west side there are two projecting points of land, the north point having a length of about one-eighth of a mile, and the south point a length of three-eighths of a mile. Between these two points is the entrance from the Pacific Ocean, one-half mile wide, with depths varying from 3 to 10 fathoms. The direction of the south point from the north point is south 16 degrees east. From the extremity of the south point a ledge extends in a direction north 30 degrees west for a distance of 2,000 feet. The depth on this ledge is from 0 to 6 fathoms. A ledge also extends out from the north point. It is not in prolongation of the north point, but leaves the shore about 700 feet northwest of the extremity of the north point and extends 500 feet in a direction south 12 degrees east. Between the two ledges there is a width of 1,000 feet, over which the depth varies from 6 to 10 fathoms. The area of the bay inside the entrance is one-half square mile. Of this area about one-half has a depth ranging from 4 to 10 fathoms. The bottom is of hard sand with occasional rocks.

In the northwest quarter of the bay are arranged several moorings, to which vessels make fast on entering the harbor, and two lumber chutes by means of which vessels are loaded. The north point protects shipping against swell coming from the northwest. The most severe storms come from the west and southwest. Against these there is no protection and vessels leave the harbor if possible when the sea becomes rough at the moorings. Steam vessels can usually get out into the open sea without difficulty, but sailing vessels caught in the harbor by the sudden appearance of rough weather make fast to extra heavy moorings and ride out the storm. Care is taken to keep the moorings in good order and to provide the vessels with good lines. No vessel has been lost at Mendocino Bay for many years past, although there have been vessels in the bay during some of the most severe storms of recent years.

The only stream of any consequence emptying into Mendocino Bay is Big River, the mouth of which is in the northeast angle of the bay. Big River has a length of 35 miles; its width at the mouth is about 200 feet. Across the mouth is a bar which is changeable in position and height. During the rainy season the channel of the river follows closely the north bank and the north edge of the bay, but during the dry season this channel is filled up, probably because there is not sufficient discharge to carry off the sand banked up across the mouth by the action of the breakers. The channel then follows the east side of the bay. There is a rise of tide of about 5 feet in the bay; the effect is felt in the river for a distance of 3 miles up from the mouth. At times the bar across the mouth of the river is almost dry at low water; at other times there has been water enough to float a coasting vessel.

I went up the river for a distance of 3 miles; the width varies from 100 to 300 feet; there is said to be a channel of about 8 feet least depth; I found over 14 feet in places. In time of freshet the river is subject to a rise of 25 feet in the upper part, and a rise of 12 feet at a point 3 miles from the bay. Near the mouth the fresh water discharge causes the flood-tide current to be weak. The river is deeply colored by sediment; this must be carried out to sea, as there does not seem to have been any considerable shoaling in the bay during the last twenty years.

One-fourth of a mile above its mouth the river is crossed by a wagon bridge about 500 feet long, built of wood and iron. The bridge contains no draw.

Mendocino City is a place of 1,000 inhabitants, situated on the high ground on the north side of the bay, and presenting a fairly neat and well kept appearance. It contains a post-office, a telegraph office, a common school, a high school, three churches, seven hotels, an Odd Fellows hall, a Masonic hall, two drug stores, five general stores, a small number of saloons, a banking house, a weekly newspaper, a few physicians, a hospital, blacksmith shops, livery stables, and other accessories of a town that is forced to be largely self-dependent. The only export of any importance is lumber, which is sawed by the Mendocino Lumber Company's mill, situated on the north bank of Big River, about one-half mile above its mouth. The lumber, in the form of logs, is brought down Big River each year during the freshet time to a point about 3 miles above the mouth, whence it is brought in small rafts to the mill as needed for sawing. The finished lumber is hauled by horses, oxen, and steam power to the chutes on the north point and there loaded on vessels.

The output of lumber is now about 16,000,000 feet per year; previous to the present depression of business it amounted to 25,000,000 feet per year.

The only steam vessel making regular trips to Mendocino City is the *Point Arena*, a steam schooner of 172 tons net tonnage. She makes weekly round trips between Mendocino City and San Francisco, and usually brings down about 160,000 feet of lumber. Two sailing vessels bring to San Francisco two loads each per month, and other steam and sailing vessels take occasional loads from the bay. The imports are about 40 tons per week of general supplies for the use of the people of Mendocino City and a small farming population in the adjacent country.

The facilities now existing are sufficient for the present trade of the port. The business men of Mendocino City claim that a breakwater built across the entrance would so improve the harbor as to cause the trade of a large section of the surrounding country to concentrate at Mendocino City, there being no good harbor within a radius of 100 miles. Along the coast of Mendocino County there are a number of landing places, but so far as I could judge from the appearance of the coast as seen from the steamer none of these landings approach so closely the conditions of a land-locked, deep-water harbor as does Mendocino Bay.

A railroad from Ukiah to Mendocino City has been talked of. Such a road would probably open up a large tract of timber, grazing, agricultural, and fruit land, the productions of which would seek an outlet by water. A railroad from Round Valley to Fort Bragg, 12 miles above Mendocino City, has also been planned. Its construction was expected to be begun some time ago, but there has been a delay, and just now there is some uncertainty as to whether or not the road will be constructed. The reported plan of the projectors of the road is to bring coal from Round Valley to Fort Bragg for shipment. There is no good harbor at the latter place, and it is predicted that the improvement of Mendocino Bay would lead to the extension of the road to Mendocino City as a shipping place.

The rates of freight and insurance on vessels trading at Mendocino Bay are somewhat higher than they would be if it were a safe harbor easily accessible. A reduction of 50 cents per thousand feet on lumber, and 50 cents per ton on other articles, is probably what could be expected to result from the improvement of the harbor at this time. The total reduction in freight on exports and imports would, in the present condition of business, amount to about $10,000 per year. If by the construction of railroads the numerous lumber mills along the coast of Mendocino County were connected with Mendocino as a shipping place, the total reduction on freights would be many times the above amount. The coast line of Mendocino County is about 90 miles long; Mendocino City is at the middle point of this line in a good situation for a central place of business. Within a radius of 15 miles there are several lumber

mills in operation, whose aggregate output is said to be over 100,000,000 feet per year. At present, however, there are no facilities for transporting this lumber to Mendocino.

The point has also been urged that Mendocino Bay is a suitable place for a harbor of refuge for the coasting fleet plying north of San Francisco. The nearest landlocked harbors are San Francisco Bay, 130 miles south, and Humboldt Bay, 110 miles north. Mendocino Bay has sufficient depth of water for the largest vessels, and the 10-fathom channel near the north point is said to be passable by an inward bound vessel during the severest weather. The disadvantages of a harbor of refuge there would be the limited deep-water area (one-fourth of a square mile) and the narrow entrance that would be left after protecting the harbor by a breakwater. The subject of a harbor of refuge for the North Pacific Coast was reported upon by a Board of Officers March 6, 1880. (See Report Chief of Engineers, 1881, p. 2621.)

I inclose herewith statements of the Mendocino Discount Bank and the Savings Bank of Mendocino for the past three years, furnished by Mr. William Heeser, secretary, a statement of the lumber carried by the vessels of the Mendocino Lumber Company during the past nine years, furnished by Mr. E. C. Williams, president, and a view of Mendocino Bay furnished by Mr. Albert Brown.

I do not consider the commerce of Mendocino Bay to be sufficiently large, at the present time, to call for the improvement of this harbor by the United States.

Very respectfully, your obedient servant,

HERBERT DEAKYNE,
Second Lieut., Corps of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

Statement of assets and liabilities of Bank of Mendocino, of Mendocino, Cal. (a mutual savings bank).

AT END OF YEAR 1892.

Assets:	
Loans on real estate	$414,426.21
Real estate	18,247.52
Due from other banks	62,381.73
Cash	30,107.07
Other assets	4,003.00
	529,165.53
Liabilities:	
Deposits	478,511.44
Reserve, surplus, and accrued interest	50,654.09
	529,165.53

AT END OF YEAR 1893.

Assets:	
Loans on real estate	$388,663.21
Real estate	49,988.19
Due from other banks	23,464.96
Other assets	1,700.00
	463,816.36
Liabilities:	
Deposits	413,464.12
Reserve, surplus, and accrued interest	50,352.24
	463,816.36

AT END OF YEAR 1894.

Assets:	
Loans on real estate	$286,260.41
Real estate	78,668.78
Due from other banks	15,181.54
Other assets	2,718.72
	382,829.45
Liabilities:	
Deposits	334,149.06
Reserve, surplus, and accrued interest	48,680.39
	382,829.45

Statement of assets and liabilities of Mendocino Discount Bank, of Mendocino, Cal.

AT END OF YEAR 1892.

Assets:	
Loans on real estate	$135,574.43
Loans on personal security	12,472.37
Bills receivable	27,275.56
Bonds	556.00
Due from other banks	41,905.28
Other assets	700.00
	218,483.64
Liabilities:	
Capital stock	68,600.00
Reserve, surplus, and accrued interest	14,471.95
Deposits	116,286.08
Collections	19,125.61
	218,483.64

AT END OF YEAR 1893.

Assets:	
Loans on real estate	$150,472.57
Loans on personal security	11,337.97
Bills receivable	9,830.47
Bonds	400.00
Due from other banks	46,472.70
Cash	4,744.46
Other assets	700.00
	223,958.17
Liabilities:	
Capital stock	68,600.00
Reserve, surplus, and accrued interest	16,770.54
Deposits	129,462.24
Collections	9,125.39
	223,958.17

AT END OF YEAR 1894.

Assets:	
Loans on real estate	$183,948.03
Loans on personal security	10,035.16
Bills receivable	5,481.10
Bonds	300.00
Due from other banks	868.77
Real estate	9,693.47
Cash	1,623.73
Other assets	700.00
	212,650.26
Liabilities:	
Capital stock	68,620.00
Reserve, surplus, and accrued interest	14,769.73
Deposits	114,094.97
Due other banks	10,502.74
Collections	4,662.82
	212,650.26

The territory on which these banks hold mortgages on real estate extends over the whole of Mendocino County and over into the borders of Humboldt County and of Lake County, some 90 miles north and south and over 40 miles east and west.

WM. HEESER, *Secretary.*

LETTER OF THE PRESIDENT OF THE MENDOCINO LUMBER COMPANY.

OFFICE OF THE MENDOCINO LUMBER COMPANY,
San Francisco, Cal., February 23, 1895.

DEAR SIR: Replying to your request for statistics regarding shipping at the port of Mendocino, we can only report definitely concerning the fleet engaged in our immediate business, which is as follows:

The average of vessels loaded by us for the last nine years is 62 vessels per annum, with 10,200,000 feet of lumber shipped. Besides these the Pacific Coast Steamship Company for much of the time has run a steamer there twice a week, and other parties have been engaged in bringing away posts and ties to some extent.

As we suggested to you as it appears to us, the great value of the place if it should be improved would be in giving a harbor of refuge for any vessel that might be in distress, as there is no place between San Francisco and Columbia River available for this purpose.

Very truly, yours,

MENDOCINO LUMBER COMPANY,
E. C. WILLIAMS, *President.*

Lieut. H. DEAKYNE,
United States Army.

S S 9.

PRELIMINARY EXAMINATION OF AMERICAN RIVER, CALIFORNIA, WITH A VIEW TO PREVENTION OF SAND FLOWING INTO THE SACRAMENTO RIVER NEAR THE CITY OF SACRAMENTO.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., August 12, 1895.

GENERAL: In compliance with section 10 of the river and harbor act of August 17, 1894, I have to submit the following report on the "preliminary examination of the American River, California, with a view to prevention of sand flowing into the Sacramento River." The first examination was made by my assistant, Lieut. Herbert Deakyne, Corps of Engineers, who examined it in a skiff during a moderate flood stage, and whose report of said examination is herewith.

On account of the stage of the river it was difficult, in fact impracticable, to see most of the sand bars in the river, which were submerged at the time; a further examination was therefore deferred until the river was at a low stage, as at present, when I made the reexamination in person on August 7 and 8 in a skiff and on foot.

After traveling about 15 miles down the river in a skiff, the latter struck a snag in one of the numerous rapids where the water was very deep and swift; the boat and contents were lost; the boatman and myself clung to the snag and reached the shore about midnight. Thereafter we walked for seven hours along the bank of the river wherever it was practicable and finally reached Sacramento afoot.

The American River, strictly speaking, is not a navigable stream, though one small steamer in 1882 (it is reported) went up as far as Folsom. At the first bridge, just above the mouth of the river, they placed rollers under the boat and rolled her around and past one approach of the bridge. At the second or railroad bridge the upper works and smokestack were removed and she passed beneath it. By means of a steam capstan and numerous warpings she reached Folsom, some 25 miles above the mouth of the river. The experiment was never repeated. About 2 miles above Folsom there is a rock dam some 70 feet, more or less, in height across the river. For 15 miles below Folsom the right bank of the river is generally high, varying from 30 to 200 feet in height. The left bank rarely exceeds 100 feet in height and frequently is not over 20 feet high.

The banks generally are rock, clay, or gravel. In this 15 miles the river at its low stage is a series of rapids. The bottom is gravel, cobbles, and bowlders.

Some fourteen or fifteen rapids were counted. The fall in this distance is estimated to exceed 5 feet per mile. The depth of water on some of the rapids where the river is wide is less than 10 inches. In narrow chutes depths as great as 6 feet were found, and moderately deep pools are found between all the rapids.

This portion of the river contains numerous gravel bars, so compacted that the floods, it is believed, could have no effect in moving them; but it was observed in descending the stream that the size of the gravel in the bars became smaller and smaller, until finally it disappeared.

For 6 miles above the mouth of the river its bed is covered with sand bars, many of which have their crests 6 feet or more above low-water surface of the stream. For about 1 mile on each side of the railroad bridge, which crosses the river 1½ or 2 miles above its mouth, the area covered by sand bars is greater than that covered by water. Some 4 or perhaps 5 miles of river, between where the gravel bars cease and sand bars commence, I could not see.

The gravel and sand bars in the bed of the river may be attributed to the mining operations which took place on the river and its tributaries prior to ten years ago. The gravel will probably remain where it now is, the sand is gradually working, in flood periods, toward and into the Sacramento River.

At present the mining on the American and its tributaries is so limited that it is believed to add almost nothing to the accumulation of débris already in the bed of the river.

The area of agricultural land cultivated and drained into this river is small as compared with other rivers in the United States draining an equal extent of territory. The area drained by this river below Folsom is stated to be 1,899 square miles. It has been estimated that the mean annual discharge of the American is about 2,600 cubic feet per second, or about 7 per cent of that of the Sacramento River.

It is known that in late years the Sacramento River below the mouth of the American has improved in depth on most of the shoals. It is probable that the sand inflow into the American River is now much less than formerly, and it is a fair inference that the Sacramento River is now capable of handling and disposing of such sand as is gradually coming from the American during its freshets.

Without a survey nothing more than a rough estimate of the quantity of sand in the American River liable to be moved can be made. We know that sand bars extend up the river at least 6 and not over 10 miles above its mouth. These bars while not continuous frequently cover more than 200 and sometimes more than 400 feet in width of the river, if it be assumed that the average width of the bars is 250 feet and the aggregate length is 8 miles there would result, approximately, 242 acres of sand to be controlled. It is believed that this acreage is under rather than over estimated. To attempt to control this sand by barriers extending across the river near its mouth would be injudicious, as they would cause overflows and damage to thousands of acres of valuable lowland. Another way to impound most of the sand would be by brush wing dams, or pens, on each side of the river. This, too, would be objectionable, as many of these bars are islands near the middle of the river, and these, on account of the concentration of the current by wing dams, would surely be scoured out and transferred into the Sacramento River. The most effective method to hold the sand would be by means of brush mattresses, built on top of and covering the bars and ballasted

there with rock or heavy gravel. This would require about 1,170,000 cubic yards of brush and about 400,000 cubic yards of rock or gravel; estimating the brush work at 75 cents per cubic yard and the gravel at 50 cents, the estimated cost of the work would be $1,077,500. The interest on this amount at 3 per cent would be $32,325 per annum, this amount is believed to be greatly in excess of what would be required to annually handle in the lower Sacramento River any sands which might enter it from the American.

As the estimated cost of impounding the sand in the American is so great, as the outflow is now so gradual and apparently decreasing, and the damage to the Sacramento from the sands, if any, is so slight, it is believed that the expense of preventing this inflow of sand is incommensurate with the benefits likely to result.

Hence, in my opinion, the American River is not worthy of improvement.

Respectfully submitted.

W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., August 19, 1895.

Respectfully forwarded to the Chief of Engineers.

The conclusion drawn in these reports agrees with those stated in the reports of January 10, 1881, and of January 20, 1882, published on pages 2491 and 2573, respectively, of the Reports of the Chief of Engineers for those years. This conclusion is there stated to be that, by reason of the necessity of acquiring highly cultivated lands for impounding basins, it is considered to be impracticable, at reasonable cost, to restrain detritus in the lower American.

For this reason, in spite of the desirableness of the proposed end, the American River is considered to be not worthy of improvement.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF LIEUT. HERBERT DEAKYNE, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., March 11, 1895.

SIR: I have the honor to submit the following report upon an examination of the American River, made in accordance with your orders. This examination was required by law to be made "with a view to prevention of sand flowing into the Sacramento River, near the city of Sacramento."

I proceeded from San Francisco to Folsom, Cal., March 8, and descended the American River from Folsom to Sacramento, March 9. The distance is about 25 miles.

A dam has been built across the river at the State Penitentiary, about 2 miles above the town of Folsom. The river falls over the dam with a fall of about 15 feet in its present stage; between the dam and the town of Folsom, the river is simply a succession of rapids. The bed of the river is rocky; the banks are high and rather steep. Below Folsom the river varies in width from 100 to 300 feet; it flows mostly over a stony bed, broken in numerous places by shoals, over which there is a rapid current. Depths varying from 2 to 7 feet were found in this part of the river. Just now the river is said to be some 2 to 3 feet above low-water stage at Folsom. Evidences of former hydraulic mining are visible in the vicinity of Folsom; the banks of the river are formed chiefly of mining débris in the form of sand, gravel, pebbles,

and cobblestones. The right bank of the river is usually higher than the left. A few miles below Folsom the right bank of the river is a high clay bluff, which is being cut away by the river. Here every foot of encroachment on the bank causes hundreds of cubic yards of earth to fall into the river. There are also in the vicinity of Folsom some small mining operations going on, the resulting débris being carried down into the American River by sluices.

Along the lower half of the portion of the river examined the land is utilized for grazing purposes and for fruit orchards and hop fields. The banks are lower and the bed of the river is formed of soft material, sand or mud. The width varies from 400 to 800 feet; the depth is usually small, although as much as 10 feet was found in one place. The banks of this portion of the river are sandy; the river is sometimes divided into two or more parts by bars of sand. In places it could be seen that erosion of the sandy banks was in active progress.

The river is subject to a rise of probably 15 or 20 feet at Folsom. At the mouth, the rise is that of the Sacramento River, into which the American River empties about half a mile above the railroad bridge over the former at the city of Sacramento. The Sacramento River is now some 13 feet above its low-water stage. In its flood stage it rises a few feet higher than its present stage.

The current of the American River varies considerably in velocity; it seldom fell below 3 miles per hour during my trip, while in places it reached 6 or 7 miles per hour. The water in the river is deeply covered by sediment.

There is no regular navigation on the river. It was once ascended by a steamboat as far as Folsom, but no attempt at navigation has been made recently, probably because during the time of year when navigation would be desirable the river is low and offers serious impediments in the way of bars and strong currents.

For the prevention of sand flowing into the Sacramento River there are two general methods, either to prevent the American taking up sediment or to cause a deposit of sediment before it flows into the Sacramento. The first method would call for the stoppage of all mining operations by which débris is carried into the river, and the protection of the banks of the river wherever encroachment is going on. To insure a deposition of the sediment it would be necessary to build a dam or dams across the river to form a pool or pools in which the sediment would collect. The work of protecting the banks or of building dams would doubtless be very expensive. The construction of a dam across the river would also destroy the possibility of navigating the river, and while in its present condition the navigability of the river is of little importance, there may come a time when navigation may be carried on.

The sediment brought down by the American River ought to be carried off by the Sacramento River, unless the current of the latter is slower than that of the former. In their present stages the currents of the two rivers differ but little at their junction. As to their relative velocities at other stages I have no information.

In view of the great expense of either dams or thorough shore protection on the American River, I am inclined to think that commensurate benefit would not be derived by the Sacramento River, and I have therefore to state that I do not consider the American River worthy of improvement.

Very respectfully, your obedient servant,

HERBERT DEAKYNE,
Second Lieutenant, Corps of Engineers.

Maj. W. H. HEUER,
Corps of Engineers, U. S. A.

S S 10.

SURVEY OF OLD RIVER BRANCH OF SAN JOAQUIN RIVER, CALIFORNIA.

[Printed in House Ex. Doc. No. 225, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1895.

SIR: The river and harbor act of August 17, 1894, provides for a survey of Old River branch of San Joaquin River, California, and I have now the honor to inclose a copy of report of January 9, 1895, with map,* by Maj. W. H. Heuer, Corps of Engineers, submitted under this item of the act mentioned.

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* Omitted. Printed in House Ex. Doc. No. 225, Fifty-third Congress, third session.

The project proposed by Major Heuer contemplates obtaining a depth of 5 feet in a channel 50 feet wide through the shoals between Naglees Ferry and Naglee's warehouse, at an estimated cost of $2,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., January 9, 1895.

GENERAL: In compliance with the act of Congress of August 17, 1894, and your instructions, I submit herewith a tracing of that part of Old River branch of San Joaquin River, California, which has been obstructed by sand bars. The preliminary examination of the river was made in August, 1892, and the report thereon printed as House Ex. Doc. No. 18, Fifty-second Congress, second session.

To obtain a depth of 5 feet of water in a channel 50 feet wide through these shoals will require the removal of about 8,000 cubic yards of material, measured in place. To get a dredge on the ground and back to her work will cost about $800, and the dredging can be done at an estimated cost of 15 cents per cubic yard; or the total estimated cost of the removal of the shoal is $2,000.

As the commerce over this section of the river averages nearly 5,000 tons of wheat and barley per year, it is thought to be worthy of improvement to the extent of removing these shoals.

Respectfully submitted.

W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 10, 1895.

Respectfully forwarded, recommended.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

S S 11.

SURVEY OF CRESCENT CITY HARBOR, CALIFORNIA.

[Printed in House Ex. Doc. No. 231, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1895.

SIR: The river and harbor act of August 17, 1894, provides for a survey of Crescent City Harbor, California, and requires the cost of improvement to be estimated. The duty of making this survey was

assigned to Maj. W. H. Heuer, Corps of Engineers, and I have now the honor to submit the accompanying copy of his report January 9, 1895, with map* on the subject.

Major Heuer submits a project for the removal of three rocks from Crescent City Harbor, and estimates that the work will cost $285,000. At the same time he states that in his opinion the removal of these rocks, or either of them, is not a public necessity; the expense of removing them would be incommensurate with the advantages to be derived from their removal, and hence with the present amount of commerce the roadstead of Crescent City is not worthy of improvement to the extent of removing these rocks. The recommendations of Major Heuer are concurred in by Col. G. H. Mendell, Corps of Engineers, division engineer.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. W. H. HEUER, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., January 9, 1895.

GENERAL: In compliance with the act of Congress of August 17, 1894, and your letter of instructions, a survey of portions of the Crescent City Harbor was recently made.

A tracing showing the harbor, taken from surveys made by the U. S. Coast Survey in 1859, with the location of rocks, which for convenience have been called A, B, C, marked on the tracing, is herewith.

As no material changes have occurred in this harbor, an open roadstead, since the survey of 1859, a resurvey was not deemed necessary, but surveys and developments of the three rocks herein referred to were made, and the results are shown on above tracing.

The roadstead has been generally described in various official reports of examinations made in 1867, 1877, 1887, and finally in 1892. All reports on the harbor based on examinations indicate that the expense attending the construction of a breakwater there is so great that it is incommensurate with the benefits likely to result therefrom. In the last previous report on this subject, December 5, 1892, printed in House Ex. Doc. No. 29, Fifty-second Congress, second session, reference was made to a few sunken rocks in the harbor, and a survey of them was recommended.

The first of these rocks, called Fauntleroy Rock—on the tracing it is marked A—is partly awash at low water. Its volume to a depth of 24 feet is approximately 3,550 cubic yards; to a depth of 33 feet its volume is estimated at 7,100 cubic yards. The channel is on either side of this rock, that on the west side being fully 400 feet in width, that on the east side being about 700 feet in clear width. If this rock were removed there would result a channel width of about 1,100 feet.

The other two sunken rocks are on the easterly side of the channel. That marked B is a little less than 700 feet east of Fauntleroy Rock, has a least depth of 10 feet of water on its crest, and to a depth of 24

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* Omitted. Printed in House Ex. Doc. No. 231, Fifty-third Congress, third session.

feet its volume is computed at 1,900 cubic yards. To a depth of 33 feet its volume is estimated at about 5,000 cubic yards. If this rock were removed it would increase the width of the channel about 300 feet. The third rock, C, is situated on the easterly side of the channel, about 800 feet southeast of rock B. This rock has a least depth of 13½ feet on its crest; its volume above the 24-foot depth is about 250 cubic yards; above the 33-foot depth its volume is estimated at 2,225 cubic yards.

The roadstead or harbor of Cresent City is subject to frequent and long-continued fogs, and during strong southerly, southeasterly, or southwesterly winds is subject to violent and heavy seas, rendering it under such circumstances an unsafe harbor for vessels. The removal of either or all of the rocks herein referred to would make it safer and easier for a vessel in approaching and leaving the only wharf in the place, but with any southerly sea on she could not fasten to the wharf nor land either freight or passengers, hence would not be likely to attempt an entrance to the harbor.

The advantage in the removal of the rocks would be in the increased safety to the vessel in departing on the approach of or during a southerly storm. It is a matter of frequent occurrence during foggy or dark nights, when the small steamer plying to Crescent City is about to leave that place, that a small boat with a lantern on board is sent out to Fauntleroy Rock to indicate to the steamer its position. The removal of this rock would therefore be of some advantage to the safety of shipping, and might prevent the loss of a vessel, and perhaps of life. It is not known to me, however, that any vessel or life has been lost in consequence of the presence of Fauntleroy Rock, and the question to be determined to govern whether or not it is advisable to remove the rock is that of the expense compared with the benefits to be derived from its removal.

Loaded vessels plying to and from Crescent City draw only from 12 to 13 feet of water, but by reason of the heavy swells and sometimes violent seas, if this rock be removed it should be done to at least a depth of 24 feet below mean low water. This means the removal of about 3,550 cubic yards of rock in an open roadstead at an estimated cost of $50 per cubic yard, or $177,500.

Next in importance is the removal of rock B, containing 1,900 cubic yards, and at $50 per cubic yard the estimated cost of removal is $95,000. It is believed that this rock alone could not be removed for this amount, but only in connection with Fauntleroy Rock, the same plant and appliances becoming available for both works.

The removal of rock C is believed to be of far less importance than that of either of the others. Its volume, above the 24-foot depth, is estimated at 250 cubic yards; this, at $50, is $12,500. As a separate proposition it is believed that this rock alone could not be removed for less than $100 per cubic yard, but by removing all three rocks it might be possible to remove this at the estimated cost of $50 per cubic yard.

Of the three rocks referred to, it is thought that Fauntleroy Rock (A) is the more dangerous; but if this rock were removed, it is very improbable that the rates of freight or insurance to and from Crescent City would be reduced. The only reason, therefore, that can reasonably be urged for the removal of Fauntleroy and the other rocks herein referred to is that it might possibly prevent the loss of life. The same reasoning might equally well apply to hundreds, perhaps thousands, of other rocks along the coast.

In my opinion the removal of these rocks or either of them is not a public necessity. The expense of removing them would be incommen-

surate with the advantages to be derived from their removal, and hence, with the present amount of commerce, the roadstead of Crescent City is not worthy of improvement to the extent of removing these rocks.

Respectfully submitted.

W. H. HEUER,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 10, 1895.

Respectfully forwarded.

While these rocks are an obstruction to navigation and a danger to vessels, the cost of their removal is thought to be out of all proportion to the advantage thereby to be gained.

The recommendations of the district engineer are concurred in.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

APPENDIX T T.

IMPROVEMENT OF CERTAIN RIVERS AND HARBORS IN OREGON, WASHINGTON, AND IDAHO.

REPORT OF CAPT. THOMAS W. SYMONS, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Coquille River, Oregon.
2. Coquille River, Oregon, between Coquille City and Myrtle Point.
3. Entrance to Coos Bay and Harbor, Oregon.
4. Harbor at Coos Bay, Oregon.
5. Umpqua River, Oregon.
6. Mouth of Siuslaw River, Oregon.
7. Yaquina Bay, Oregon.
8. Tillamook Bay and Bar, Oregon.
9. Entrance to Nehalem Bay, Oregon.
10. Upper Snake River, Idaho, between Huntington Bridge and Seven Devils Mining District.
11. Upper Columbia and Snake Rivers, Oregon and Washington.
12. Columbia River between head of Rock Island Rapids and foot of Priest Rapids, Washington.
13. Columbia River from Rock Island Rapids to Foster Creek Rapids, Washington.
14. Willapa River and Harbor, Washington.
15. Grays Harbor and Chehalis River, Washington.
16. Chehalis River, Washington.
17. Harbor at Olympia, Wash.
18. Waterway connecting Puget Sound with Lakes Union and Washington.
19. Everett Harbor, Washington.
20. Swinomish Slough, Washington.
21. Puget Sound and its tributary waters, Washington.

EXAMINATIONS AND SURVEYS.

22. Umpqua River, Oregon, from Scottsburg to Elkton Rapids.
23. Yaquina Bay, Oregon.
24. Quillayute Harbor and River, Washington.
25. Clallam Bay, Washington.
26. Puget Sound, Washington, from Hoods Canal to North Bay.
27. Bellingham Bay, Washington.
28. Okanogan River, Washington.
29. Flathead River, Montana, and Pend d'Oreille River, Montana.
30. North River, Washington.
31. Kootenai River, above the town of Jennings, Mont.
32. Port Orford, Oreg.
33. Coos River, Oregon.
34. Alsea River, Oregon.
35. Nestucca River, Oregon.
36. Nooksack River, Washington.
37. Kootenai River, Idaho, between Bonners Ferry and the international boundary line.
38. Grays Harbor, Washington.
39. Columbia River, Washington, from Rock Island Rapids to the Okanogan River.

HARBOR LINES.

40. Puget Sound, at Seattle and Ballard, Wash.
41. Hoquiam Harbor, Washington.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., July 17, 1895.

GENERAL: I have the honor to forward herewith * * * annual reports * * * for the year ending June 30, 1895, for the river and harbor works under my charge.

* * * * * * *

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

T T 1.

IMPROVEMENT OF COQUILLE RIVER, OREGON.

GENERAL IMPROVEMENT.

Description of original condition.—At the time the work of improvement was begun the entrance to the Coquille River was considered very dangerous. It was by a long, tortuous, and narrow channel skirting the south headland, and studded with rocks from beyond the bar on the outside to a distance of one-half mile inside. The depth at low water was only about 3 feet, and the position of the bar channel was constantly shifting. The channel, at long intervals, broke through the north spit, and ran directly out to sea just south of Rackliffe Rock, but did not remain long in this position. The entrance then was comparatively safe, and the channel was at its very best. The mean rise of tide was 4.1 feet.

Plan of improvement.—The plan of improvement is to construct two nearly parallel high-tide stone jetties, 600 feet apart at their outer extremities, to run out to sea a sufficient distance to open and maintain a channel over the bar, with a least depth of 8 feet at low water, the north jetty starting from Rackliffe Rock and the south jetty from a point on the left bank inside the entrance. The cost of this work, as estimated in 1878 by Maj. J. M. Wilson, is $164,200. The law of August 11, 1888, authorized $5,000 to be expended in addition for snagging between Coquille City and Myrtle Point.

The law of September 19, 1890, authorized an amount not to exceed $3,000 to be used in snagging.

A careful estimate of the cost of completing the works at the entrance to the Coquille, in accordance with the plan of improvement given above, was made in 1892, and it was found to be $180,000. The correspondence on this subject is given under the head of "Recommendations and remarks," page 2663, Report of Chief of Engineers, 1892.

Up to this time $105,000 had been appropriated for the work. This makes the total estimated cost of the work $285,000.

APPROPRIATIONS.

Act of—		Act of—	
July 14, 1880	$10,000	September 19, 1890	$30,000
August 2, 1882	10,000	July 13, 1892	25,000
July 5, 1884	10,000	August 17, 1894	20,000
August 5, 1886	20,000		
August 11, 1888	25,000	Total	150,000

The estimated cost of completing the project is $135,000.

Amount expended to June 30, 1894.—The amount which has been expended on the project for the improvement of the mouth of the Coquille to June 30, 1894, was $121,050.18, and the amount expended for snagging was $6,883.90, a total of $127,934.08.

Results obtained to June 30, 1894.—The work during the year was confined to strengthening the south and north jetties. Neither jetty was extended, and the condition of the entrance was about as previously reported. The entrance has for considerable periods been straight, but winds and currents have at other times heaped the movable sands into the channel, causing the waters to spread out over a wide angle or the channel to become shallow in depth and bad in direction.

Amount expended during the fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $3,537.33.

Results obtained to June 30, 1895.—The work under the appropriation of August 17, 1894, having been but fairly commenced, no results beyond those previously reported can be claimed.

Report of operations.—It was decided to change the character of the work by abandoning the old system of single-track close-pile tramway, and to adopt the regular open-work pile-bent double-track tramway, and to build the enrockment on a brush mattress.

It was also decided to do the work by contract, and it was advertised March 6, and the bids were opened April 6, 1895.

The following is an abstract of the bids received:

No.	Name and address of bidder.	Transporting pile driver from Newport, Oreg., to Bandon, Oreg.	Piles, per linear foot.	Lumber, per M feet, B. M.	Drift bolts, per pound.	Bolts, with nuts and washers, per pound	Brush mattresses, per cubic yard.	Stone, per ton.	Total.
			Cents.		*Cents.*	*Cents.*			
1	D. Cameron and J. L. Robertson, Portland, Oreg	$250.00	10	$11.00	5	6	$0.50	$0.85	$10,813.50
2	Rich. Hoyt, Portland, Oreg	100.00	6	7.00	5	5	50.00	.50	39,998.00
3	A. G. Shepard and John M. Leavens, Portland, Oreg	200.00	9	10.00	5	5	.50	.60	8 114.50
4	Perry Hinkle, Portland, Oreg	250.00	10	11.00	3	3	.60	.55	7,793.00
5	J. M. Nickum and W. Jacobsen, Portland, Oreg	200.00	8	9.50	3	4½	.35	.58	7.439.75
6	E. G. Worth and C. E. Fields, Portland, Oreg	275.00	8½	11.50	2½	4	.39	.63	8,420.25
7	Dickinson & Co., Tacoma, Wash	340.00	10	11.00	4	5	.70	.75	9,997.50
8	James A. Laughead and Luther W. Record, Bandon, Oreg	483.00	20	19.50	5	10	1.25	.88	13,179.25
9	Daniel Kern, Portland, Oreg	200.00	8	10.00	5	5	.48	.79	9,943.00
10	Charles W. Tower, Marshfield, Oreg	200.00	14	11.00	6	7	.50	.91	11,636.50
11	Hans R. Reed, Bandon, Oreg	250.00	20	20.00	6	10	.90	1.20	15,987.50

The contract was awarded to the lowest bidders, Nickum & Jacobsen. For doing the work of tramway extension the Yaquina Bay pile driver was borrowed and shipped to the Coquille. This saves the appropriation the burden of building a machine at a cost of not less than $5,000.

The contractors commenced their operations the latter part of April, 1895, getting the Yaquina pile driver into position and procuring supplies of piles and lumber.

On May 4 a tunnel was started in the Tupper Rock. This rock is extremely hard, and progress very slow. The tunnel is of small dimensions.

At the end of the fiscal year the work of driving the tunnel was still in progress. It is to be driven in 40 feet and have galleries from its end both ways. These will be charged with powder, and the contractors expect that the explosion thereof will break down enough rock for them to complete their contract. It is expected that the tunnel work will be completed about July 15.

In the meantime the work of reconstructing the tramway is progressing, the progress, however, being slow.

No work has been done, or is projected on the north jetty. The pile tramway of this jetty has been injured by storm and drift, and will probably be practically destroyed before work is again resumed on it, but this is not regarded as of any consequence, as the plan of doing the work is changed and the old tramway has no place in the new plan that would justify the expenditure of money in its protection.

Recommendations and remarks.—An appropriation of $50,000 is recommended as the amount of money that can be profitably expended on the project during the next fiscal year. There is a bad rock in the harbor gorge, which was recently found by the steamer *Bandorille*, and upon which its shaft was broken. The removal of this rock is desirable, and should be undertaken at the earliest date practicable in connection with the other work of improving the entrance.

Future operations.—Future operations will consist in continuing the work of repairing and extending the south jetty under contract. I think that with any future appropriations the same work should continue until this south jetty be wholly completed.

The report of Capt. R. S. Littlefield, in personal charge of the work, is herewith.

Money statement.

July 1, 1894, balance unexpended		$2,065.92
Amount appropriated by act of August 17, 1894		20,000.00
		22,065.92
June 30, 1895, amount expended during fiscal year		3,537.33
July 1, 1895, balance unexpended		18,528.59
July 1, 1895, outstanding liabilities	$150.00	
July 1, 1895, amount covered by uncompleted contracts	7,439.75	
		7,589.75
July 1, 1895, balance available		10,938.84
Amount (estimated) required for completion of existing project		135,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

REPORT OF CAPT. R. S. LITTLEFIELD, INSPECTOR.

BANDON, OREG., *June 5, 1895.*

CAPTAIN: I have the honor to submit the following report of operations on the improvement of Coquille River, Oregon (general improvement), for the fiscal year ending June 30, 1895:

No work was done by hired labor except that which was necessary to properly care for the plant.

A contract for an extension of 400 feet to the south jetty was made early in April with Nickum & Jacobsen, of Portland, Oreg. The pile driver heretofore in use on

the Yaquina improvement was transferred by them to the Coquille, reaching the latter place on April 24 by the steamer *Bandorille*. The pile driver was transferred from the steamer to cars on the south jetty quarry track, the upper Coquille snag scow being used for that purpose. It was then taken on the cars to the site of the permanent turn-out, 64 feet long, subsequently built by the contractors to accommodate double-track trucks of the pile driver, where the various parts were reassembled.

A 16-ton Fairbanks scale, furnished by the contractors, to be used in weighing the cars loaded with rock, was put in on the line of the quarry railway, far enough from the quarry to be out of the reach of the blasts.

The contractors selected the large rock bluff known as Tupper Rock from which to obtain rock for the jetty. Stone used heretofore on the jetty was obtained from this rock. The contractors' plan is to tunnel into the rock a distance of 40 feet, where a chamber and shaft will be made to receive the powder. The intention is to dislodge with one great blast all the stone required by them in their existing contract, and to make the blast before setting up derricks and other necessary machinery, and rebuilding the double-track self-acting inclined plane heretofore used in moving the empty and loaded cars between the quarry and the yard 35 feet lower down, work which would be liable to be damaged by the blasts if completed beforehand.

The tunnel was commenced on May 4, and is being driven as fast as the appliances at hand will permit, the work being prosecuted without any interruption by eight-hour shifts, with two men on a shift. The tunnel is 2½ feet wide and 3 feet high, and at this date has progressed 18 feet. Its dimensions are no greater than necessary to permit men to work in it in a cramped position. The rock is extremely hard to drill, the cut at times, of a sharpened and well-tempered drill, not exceeding one-fourth of an inch. The blind seams, however, which penetrate the rock, facilitate its removal. The tunnel and chambers can not be completed and the blast made until late in July. The contractors have on hand, or have ordered for early delivery, all powder, tools, and other material and appliances requisite for quarry operations, and have cut about 25 cords of fire wood from drift timber near the quarry for engine fuel.

During the year two bents of the close piling at the end of the south jetty were carried away by drift.

A breach was made in the north jetty piling by the drift at a point just outside of the permanent high-water beach line, and about the middle of the jetty. The breach in the south row is 18 feet wide, and that in the north row about 60 feet.

The amount of drift passing out at sea from the Coquille is probably larger than at any other harbor now under improvement by the Government on this coast.

The rock heretofore dumped along the channel side of the south jetty shows no indication of having settled during the year.

Throughout the year the channel over the bar has remained straight and unshifting, and parallel to the south jetty. This is favorable to the maintenance of a good channel depth.

Most vessels trading at this port sail in without delay if there is a "commanding breeze," thus dispensing with the use of a tug. Outward-bound vessels are without exception towed out on the flood tide.

The woolen mill located at Bandon, of which mention was made in report for 1894, has been in operation throughout the year. For the first six months it was run only at half capacity; at present it is running night and day. This mill used during the year 46.58 tons of wool and employed 46 hands. The value of supplies, including dyes, etc., amounted to $7,094.

The product for the year, valued at $30,000, was as follows:

Blankets, colored	pairs	2,532
Blankets, white	do	1,204
Flannel	yards	14,000
Robes	number	1,200
Cassimere	yards	2,000
Blanketing	do	500
Yarn and bats	pounds	300

It is proposed soon to add one more set of machinery.

A broom-handle factory is in course of construction on the water front of Bandon, and piles are being driven for the erection of a salmon cannery in the same locality.

The construction at this place of an ocean steamer for the trade of this and other coast harbors is projected.

Fourteen miles above Bandon and near the bank of the river a vein of coal 4 to 5 feet thick has recently been opened. Captain Winant, of the steamer *Bandorille*, states that trials of it made by him show that it is better steam coal than any that he can get at Coos Bay.

Respectfully submitted.

R. S. LITTLEFIELD, *Inspector*.

Capt. THOMAS W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The Coquille River is in the collection district of southern Oregon. Empire City, on Coos Bay, is the port of entry. The nearest light-house is on Cape Arago, 12 miles northward, but a new one is now under construction at Rackliffe Rock, on the north side of the entrance to Coquille River.

The following returns relative to the commerce of the Coquille River are compiled from the monthly reports as rendered by Capt. R. S. Littlefield, in personal charge of the works. They are for the fiscal year ending June 30, 1895:

Arrivals and departures of vessels.

Coastwise steam and sail vessels.	Number.	Aggregate tonnage.
Arrivals	81	8,288.85
Departures	81	8,288.85
Total	162	16,577.70

Of the arrivals, 24 were steam vessels and 57 were sail vessels. Maximum draft of loaded vessels, 9 feet.

Exports.

Articles.	Quantity.	Articles.	Quantity.
	Tons.		*Tons.*
Apples	3	Laths	66
Broom handles	123	Match wood	344
Butter	49.7	Miscellaneous	11
Cheese	10	Potatoes	25
Chittim bark	17	Shingles	60
Cattle, live	40	Salmon	3.5
Coal	65	Wool	3.5
Hogs	16	Woolen goods	2.5
Horses (2)	1.8		
Hides	16	Total	15,836
Lumber (7,489,500 feet, B. M.)	14,979		

Imports.

Articles.	Quantity.	Articles.	Quantity.
	Tons.		*Tons.*
General merchandise	1,686.5	Material for new light-house	32.5
Machinery	75	Hay	14
Railroad iron	10		
Cannery supplies	30	Total	1,848

SUMMARY.

	Tons.	Estimated value.
Total exports	15,836	$166,278
Total imports	1,848	73,920

T T 2.

IMPROVEMENT OF COQUILLE RIVER, OREGON, BETWEEN COQUILLE CITY AND MYRTLE POINT.

Description of original condition.—The Coquille is one of the principal streams of southern Oregon. It is navigated by coasting vessels from its mouth for 25 miles to Coquille City. This part of the river has been more or less obstructed at times by snags; but no serious shoals have formed.

From Coquille City to Myrtle Point, a distance of 13 miles, the river is navigated by river craft. Here, owing to snags and bars, great trouble has always been experienced in keeping the river navigable. The various forks of the Coquille drain densely timbered territory, and at every freshet many trees, stumps, etc., are brought down. Some of these lodge at different points, forming isolated snags, or are grouped together into jams. These snags and jams, in turn, induce the formation of shoals of sand and gravel.

Three-fourths of a mile below Myrtle Point, the river branches into the Middle and North forks. Myrtle Point is situated on the Middle Fork.

Plan of improvement.—The plan of improvement adopted is to remove all snags which seriously obstruct navigation and tend to form bars in the part of the river between Coquille City and Myrtle Point, and to contract the river into a channel of 50 feet in width at certain points where shoals have formed, that the shoals may be scoured out and the desired navigable depth be maintained.

The estimated cost of the work as originally made in 1891 was $26,000.

APPROPRIATIONS.

Act of—	
July 13, 1892	$5,000
August 17, 1894	5,000
Total	10,000

Previous appropriations have been made for this portion of the river by making certain sums appropriated for the improvement of the mouth of the river available for the work on the upper river. The act of August 11, 1888, appropriated $25,000, and contained the following: "Of which, $5,000 is authorized to be expended between Coquille City and Myrtle Point," and the act of September 19, 1890, appropriated $30,000, "not exceeding $3,000 of which may, with the approval of the Chief of Engineers, be used for snagging."

Of these appropriations, $6,883.90 was expended.

Amount expended to June 30, 1894.—The amount expended under the project to June 30, 1894, was $5,000.

Results obtained to June 30, 1894.—The work has been confined to fitting up a snag boat and doing snagging on the river, between Coquille City and Myrtle Point, and building a small wing dam at Roberts Island, designed to throw more water into the main left channel.

The results immediately subsequent to the completion of the snagging operations were gratifying, as the removal of the snags was accompanied by more or less scouring. It was found, however, that since the survey and preparations of plans made in 1891 a heavy deposit has been made in the upper portion of the stretch between Myrtle Point and Coquille City. At the time of the survey there were deep pools between the bars, which latter in some instances were dry, as far as navigation was concerned, at low-water stages. These pools have to a great extent filled up with alluvial deposit since the survey was made.

Amount expended during the fiscal year ending June 30, 1895.—The amount of money expended from the appropriation during the fiscal year ending June 30, 1895, was $2,804.29.

Results obtained to June 30, 1895.—About two months' work was done on the river in snagging, sluicing out the bars, and building a deflecting dam at Rackliffe Bar. The result has been to greatly benefit the river, making navigation safer and easier. Most of the work done was of a temporary character, however.

Report of operations.—On September 12, 1894, the work of getting the snag boat ready for operations commenced, and from that time until

November 22, 1894, the work of improving the river was carried on under the personal direction of Capt. R. S. Littlefield.

During that period 375 snags were removed. Some of the snags were deeply embedded in sand and were reached by washing the sand away with a water jet provided by a force pump on board the snag boat. The water jet was also used, with good effect, to remove some of the most shallow bars.

A wing dam of brush and stone, 300 feet in length, was built from the left bank of the river at a shoal about halfway between Myrtle Point and the North Fork.

To the Roberts Island Wing Dam, built two years ago, 197 feet were added, making it practically 400 feet long.

The latest reports from the river indicate that these dams have done good work in maintaining an increased depth over the bars which they were intended to benefit.

A survey of the river from Coquille City to Myrtle Point was made in November, 1894, by Mr. David B. Ogden, assistant engineer.

Recommendations and remarks.—On September 2, 1891, I submitted a report with an estimate of the cost of getting a 4-foot channel from Coquille City to Myrtle Point. The estimate amounted to $25,972.01.

The river and harbor bill of July 13, 1892, and the bill of August 17, 1894, each appropriated $5,000 for the work. The first sum and half of the latter have been expended in keeping the river free from dangerous and annoying snags, and making a start on contraction works at two points.

During the four years that have elapsed since the original survey was made the river has continued to shoal, and in spite of the money expended but little progress has been made with the general project of putting the river into a permanently deep condition.

In order that a complete knowledge of the existing condition of the river might be had, a survey of it was made in November, 1894, by Assistant Engineer David B. Ogden. The maps of his survey are herewith.

A new project and estimate of cost is deemed imperative on account of the changed conditions since the first was made, and the fact that the money already appropriated toward the project has been expended but for temporary improvement.

The distance from Coquille City to Myrtle Point is 13 miles. For 8½ miles above Coquille City no trouble except an occasional snag is met with. For the upper 4½ miles the river is generally much shallower than it is below, and especially is this the case for the last 1¾ miles from Roberts Landing to Myrtle Point. A great portion of this length has depths of but 1 to 3 feet.

In order to make and maintain a navigable channel through this upper part of the river, it will be necessary to confine the waters between pile dikes about 60 feet apart, or between a pile dike and a strongly revetted shore, and to dredge the required channel 50 feet wide and 4 feet deep at low water, and deposit the dredged material behind the pile dikes.

Below Roberts Landing there are four shoals which it is believed can be scoured across through the agency of wing dams.

The plan proposed is shown in detail on the accompanying tracings. Its cost is estimated as follows:

For the 1¾ miles from Myrtle Point to Roberts Landing	$38,696.18
From Roberts Landing to Nancys Pinch	4,480.30
Total	43,176.48

For details of this estimate attention is invited to the report of Mr. David B. Ogden, which is herewith.

The upper branches of the Coquille River flow in deep narrow canyons. The river slopes are great and the waters swift; the hills are covered with timber, which is gradually being removed; the soil is generally of decomposed sand rock, and is readily washed.

The heavy and long-continued rains which sometimes prevail cause much soil to be washed into the river. This is aided by the clearing away of the forests. On the steep mountain slopes the rains cause many landslides, portions of which reach the river and are carried down. This inevitably results in filling the river with sediment in its lower and more gently flowing portion.

If the reach of river from Myrtle Point to Roberts Landing is contracted and cleared of obstructions so as to convert it into a narrow channel capable of maintaining a normal regimen, the sediment brought down by the rivers will be deposited below and will there form shoals and bars, and the contraction works and dredging must be extended. Just how fast this extension will be required can not now be determined.

A great many snags are annually brought down the Coquille, and some of these form obstructions to navigation which must be removed. Besides the large expenditure required to remove the existing obstructions to navigation and to remedy the existing defects of the channel of the river, continued expenditures will be required to extend the contraction works and for dredging and snag removal.

If the project herein outlined be carried out it should properly be done expeditiously and without interruption. Any small amount of money appropriated will be only useful in keeping the river temporarily navigable by removing obstructive snags, etc. The estimate submitted is, for the completion of the whole work, $43,176.48. The increase of the estimate was approved March 14, 1895.

The amount available at the close of the fiscal year is $2,195.71, leaving $40,980.77 required for its completion. This amount can be profitably expended during the year ending June 30, 1897.

Future operations.—With the balance of the appropriation of August 17, 1894, remaining on hand it will probably be found desirable to again go over the river this fall and remove all snags and prolong the contraction works to such an extent as may be found expedient.

Money statement.

Amount appropriated by act of August 17, 1894	$5,000.00
June 30, 1895, amount expended during fiscal year	2,804.29
July 1, 1895, balance unexpended	2,195.71
Amount (estimated) required for completion of existing project	40,980.77
Amount that can be profitably expended in fiscal year ending June 30, 1897	40,980.77

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. DAVID B. OGDEN, ASSISTANT ENGINEER.

PORTLAND, OREG., *January 23, 1895.*

CAPTAIN: I have the honor to submit the following report on the survey of the Coquille River, Oregon:

This survey extended from Myrtle Point to Coquille City, a distance of 13 miles.

Work on the survey was commenced November 5, 1894, and completed November 17, 1894. During this time there was no rainfall, and the river consequently reached

a very low stage, affording an excellent opportunity of observing and locating all shoals and bars.

Sounding stations were located along the right bank of the river by transit and stadia measurements. These stations were spaced from 200 to 400 feet apart, except where the river appeared shoal; at such places they were spaced 100 feet apart.

These stations served to accurately locate the right bank of the river, and frequent measurements taken from these served to locate the opposite bank. Soundings were taken on diagonal lines from the located stations to the opposite shore and thence back to the next station below, thus securing a very good idea of the hydrography of the river.

Gauges were established at Myrtle Point, the mouth of the North Fork, Arago, and Coquille City. The zero of each gauge was at the lowest known water at each place; the soundings taken were thus reduced to the common datum of extreme low water.

The Coquille River is a tidal stream and is affected during average high tides as far up as Myrtle Point. On November 15 the range of tide at the mouth of the river, as computed from the tide tables, was 4.3.

The ranges along the river on the same day were as follows:

Myrtle Point	2.2
Mouth of the North Fork	3.1
Arago	4.6
Coquille City	4.0

The accompanying map, sheet A, is a reduced copy of one compiled from notes of survey, but it shows only a single line of channel soundings, and also the "4-foot" curve, platted on from cross-soundings of the larger scale map.

Between Myrtle Point and Coquille City there are seven places where shoals of less than 4 feet at low water are found; these are numbered on the accompanying maps from Myrtle Point downstream.

Shoals Nos. 1, 2, and 3 are most serious obstructions to navigation, being of great length, composed largely of gravel, and having only from 6 inches to 2 feet of water upon them at time of low water.

The river at times past has been a tidal stream as far up as the junction of the South and Middle Forks, 41 miles above its mouth, but during recent years landslides have occurred along the head waters and the stream has brought down much sand and gravel, which filled the bed of the river as far down as Roberts Landing, thus making the range of tide at Myrtle Point but 2 feet, while formerly it was 4½ feet.

Shoals Nos. 1, 2, and 3 were impassable by steamers during the time of survey, and the two daily steamers from Coquille City were obliged to stop at Roberts Landing and send passengers and freight by stage to Myrtle Point.

Shoals 4, 5, and 6 are short and composed wholly of sand.

The banks of the river are generally quite firm, scouring away but little from the action of the water, except in several of the sharp bends, where they have cut and continue to do so to a great extent. The most noticeable of these changes in the course of the river have taken place at the mouth of the North Fork and at Norway. At these points sites of the channels of twenty-five years ago are now from 300 to 400 feet inland.

The former project of improvement was that of "deepening the channel from Coquille City to Myrtle Point to 4 feet at mean low depth."

This, according to plan proposed from survey of 1891, was to be accomplished by means of "contraction works" at the three principal shoals, "letting the current remove the deposit."

During the past year wing dams of brush and stone have been constructed as an experiment at Shoals 1 and 3, as shown on accompanying maps, but whether these dams will prove effectual in causing the stream to scour out a channel at these points can not be determined until after the abatement of the next flood. It is my opinion, however, that scouring by means of contraction can not be depended upon to remove the heavy material of which Shoals 1, 2, and 3 are composed, and even should these shoals be deepened by this method it would but shift the difficulty to some point downstream, there being no deep holes for deposit for some distance; thus the obstruction would not be removed, but its location simply changed.

If this "four-foot" project to Myrtle Point is to be carried out the only practicable method of securing this depth is in my opinion by means of dredging, in which case I would recommend that the material taken out of the channel be deposited on either side and retained there by means of pile dikes. This would contract the channel at time of low water and thus, possibly, keep it clear in future.

At Shoals 4, 5, 6, and 7 I would recommend the construction of wing dams of brush and stone similar to those recently built at Shoals 1 and 3, as at these points the shoals are very short and are composed wholly of sand, which will very readily scour out and deposit itself in the holes below them. These dams should be carried

to the height of high tide during time of low water. The banks opposite these dams should be protected by riprap of brush and rock to prevent their cutting away.

Upon the accompanying tracing, sheet B, is shown the location and plan of proposed improvements.

The following estimate is based upon a continuous channel of not less than 4 feet at low water from Coquille City to Myrtle Point.

Where the channel is dredged it is estimated 50 feet at bottom with 1 to 1 side slopes:

Pile dike.

Brush, per 100 linear feet, 90 cubic yards, at 60 cents	$54.00
Stone, per 100 linear feet, 33 cubic yards, at $1.50	49.50
Piling, per 100 linear feet, 680 linear feet, at 10 cents	68.00
Braces, per 100 linear feet, 1,380 feet, B. M., at $20	27.60
Bolts and washers, per 100 linear feet, 221 pounds, at 4 cents	8.84
Nails and spikes	1.16
Cost per 100 feet	209.10
Cost per linear foot in place	2.09

Shore protection.

Brush, per 100 linear feet, 67 cubic yards, at 60 cents	$40.20
Stone, per 100 linear feet, 29 cubic yards, at $1.50	43.50
Piles, per 100 linear feet, 340 linear feet, at 10 cents	34.00
Braces, per 100 linear feet, 700 feet, B. M., at $20	14.00
Bolts and washers, per 100 linear feet, 110 pounds, at 10 cents	4.40
Nails and spikes	.90
Cost per 100 feet	137.00
Cost per linear foot in place	1.37

Shoal No. 1:	
Dredging 5,687 cubic yards of gravel, at 35 cents	1,990.45
2,400 linear feet pile dike, at $2.09	5,016.00
500 linear feet shore protection, at $1.37	685.00
Total	7,691.45
Between Shoals Nos. 1 and 2:	
Dredging 4,744 cubic yards sand, at 20 cents	948.80
1,500 linear feet pile dike, at $2.09	3,135.00
400 linear feet pile shore protection, at $1.37	548.00
Total	4,631.80
Shoal No. 2:	
Dredging 7,463 cubic yards gravel, at 35 cents	2,612.05
2,100 linear feet pile dike, at $2.09	4,389.00
700 linear feet shore protection, at $1.37	959.00
Total	7,960.05
Between Shoals Nos. 2 and 3:	
Dredging 2,792 cubic yards sand, at 20 cents	558.50
1,680 linear feet pile dike, at $2.09	3,511.20
1,300 linear feet pile shore protection, at $1.37	1,781.00
Total	5,850.70
Shoal No. 3:	
Dredging 3,161 cubic yards gravel, at 35 cents	1,106.35
700 linear feet pile dike, at $2.09	1,463.00
700 linear feet pile shore protection, at $1.37	959.00
Total	3,528.35
Below Shoal No. 3:	
Dredging 2,500 cubic yards sand, at 20 cents	500.00
2,400 linear feet pile dike, at $2.09	5,016.00
Total	5,516.00

Total estimate from Myrtle Point to Roberts Landing.

Shoal No. 1	$7,691.45
Between Shoals Nos. 1 and 2	4,631.80
Shoal No. 2	7,960.05
Between Shoals Nos. 2 and 3	5,850.70
Shoal No. 3	3,528.35
Below Shoal No. 3	5,516.00
	35,178.35
Superintendence and contingencies, 10 per cent	3,517.83
Total	38,696.18

Shoal No. 4:

460 cubic yards stone and brush dam, at $1.30 per yard	598.00
100 linear feet stone and brush riprap, end of dam, at $1 per foot	100.00
400 linear feet stone and brush riprap, opposite dam, at $1 per foot	400.00
Total	1,098.00

Shoal No. 5:

500 cubic yards stone and brush dam, at $1.30	650.00
100 linear feet stone and brush riprap, end of dam, at $1	100.00
400 linear feet stone and brush riprap, opposite dam, at $1	400.00
Total	1,150.00

Shoal No. 6:

270 cubic yards stone and brush dam, at $1.30	351.00
100 linear feet stone and brush riprap, end of dam, at $1	100.00
250 linear feet stone and brush riprap, opposite dam, at $1	250.00
Total	701.00

Shoal No. 7:

480 cubic yards brush and stone dam, at $1.30	624.00
100 linear feet brush and stone riprap, end of dam, at $1	100.00
400 linear feet brush and stone riprap, opposite dam, at $1	400.00
Total	1,124.00

Total estimate from Roberts Landing to Nancys Pinch.

Shoal No. 4	$1,098.00
Shoal No. 5	1,150.00
Shoal No. 6	701.00
Shoal No. 7	1,124.00
	4,073.00
Superintendence and contingencies, 10 per cent	407.30
Total	4,480.30

Cost of improvement, Myrtle Point to Roberts Landing	38,696.18
Cost of improvement, Roberts Landing to Nancys Pinch	4,480.30
Total	43,176.48

Below Nancys Pinch to Coquille City no work is necessary.

The accompanying maps (sheets A and B), transmitted herewith, form part of this report.

Respectfully submitted.

DAVID B. OGDEN, *Assistant Engineer.*

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

REPORT OF CAPT. R. S. LITTLEFIELD, INSPECTOR.

BANDON, OREG., *May 9, 1895.*

CAPTAIN: I have the honor to report as follows on snagging operations on the upper Coquille River, Oregon, during the present fiscal year:

In compliance with your orders of September 8, 1894, directing me to fit up the snag scow for operations on the Upper Coquille River between Coquille City and Myrtle Point, the hoisting machinery at the quarry belonging to the general improvement of the Coquille River was transferred to the snag scow belonging to the upper river improvement which had been moored in the lagoon.

At a subsequent high tide the scow was warped out of the lagoon and moored to the wharf at Bandon, where the barnacles were scraped from the sides, the seams above the water line recalked, and some necessary repairs made to the roof of the quarters. A blacksmith shop was built at the stern and the hoisting machinery and Blake steam pump put in place. On September 21 and 22 the scow was towed by the steamer *Alert* to a place on the upper river just above Arago, where the river was most obstructed by snags.

Operations were commenced on September 24 and continued until November 19, when, in compliance with orders received from you, work was suspended. On November 20 and 21 the scow was moved by the tide, assisted by its steam appliance, to Coquille City, where all of the crew except the engineer were discharged. On November 22 the scow was towed by the steamer *Dispatch* to Bandon and from thence taken to moorings in the lagoon near the south jetty.

The crew of the snag scow, including the diver, diver's helper, blacksmith, and cook, consisted of from 8 to 11 men during the season. These were all hired on the upper river.

A small gasoline launch was used as a tender in towing the snag scow, stone and brush scows, and in supplying fuel. The launch was also useful in searching for submerged snags. For this purpose a gas pipe, 20 feet long, was suspended by ropes in a horizontal position athwartships under the launch. The pipe was adjusted to a depth of 4 feet at low water. The launch thus equipped, passing over the channel of the river, would disclose by the contact with the pipe any obstruction within a depth of 4 feet at low water.

The work of the season consisted in the removal of the principal obstructing snags on the entire reach between Coquille City and Myrtle Point, the construction of a wing dam at Rackliffe Bar below Myrtle Point, the extension and raising of the wing dam at Roberts Island Bar, the construction of which was commenced in 1892, and the reducing of the shoals at Rackliffe and Roberts Island bars and at the mouth of the North Fork.

During the season 375 snags were removed. Of these 194 were large and 181 small. The large snags were transferred to the side of the river directly by the snag scow, the small ones were dumped on a tender scow and transferred to shoal water at the side of the river. Most of the snags were removed from bends in the river, which had not been snagged in previous years owing to necessity of snagging elsewhere.

Eight scow loads of small drift, most of which was passed up by the diver, were removed.

About 500 pounds of No. 1 giant powder were used in blasting snags and stumps.

In some cases, where the snags were deeply embedded, the embedding material was removed or loosened up by the use of the water jet, so as to permit of the passing of a chain around the snag and reducing the resistance to removal.

The experience with the steam pump and water jet this season, in connection with snag pulling, points to it as a valuable adjunct in future snagging operations.

At Rackliffe Bar, the shoalest place on the river below Myrtle Point, an experimental wing dam 300 feet long was built of brush and stone, the material being obtained from the bank of the river in the vicinity. The brush was in alternate transverse and longitudinal layers and covered with a soft sandstone, which was easily quarried.

The wing dam at Roberts Island Bar, built in 1892, was built up to the level of high tide and extended, brush and stone being used in the same manner as at Rackliffe Bar.

In the construction of these dams 32 scow loads of willow brush and 238 cubic yards of stone were used.

I could not observe any beneficial effects due to the contraction of the channel by the wing dams. This can not be determined until after the abatement of the water during the coming summer. The steamboat masters, however, estimate that there is an increased depth of 1 to 1½ feet.

The reduction of the Roberts Island and Rackliffe bars, and of that at the confluence of the North Fork, was attempted by the use of a water jet supplied from the steam pump on board the snag scow, the nozzle of the jet pipe being held in

direct contact with the material of the bar. A noticeable improvement was produced at the mouth of the North Fork, but at the other bars very little increased depth was obtained owing to the fact that they were composed of large gravel.

No great freshets have occurred in the river since the snagging operations of 1892; hence few new snags have been deposited since then. As a consequence, the snagging operations of the present season have left the channel of the river freer from snags than it has been at any time heretofore.

The reach of river between Roberts Landing and Myrtle Point, however, is little susceptible of improvement by snagging. The snags there are few, the river wide and filled with a deposit of heavy gravel brought down by past freshets of extraordinary magnitude, which occur at long intervals.

The periodic great freshets referred to cause landslides at the head waters of the river in the Coast Range Mountains, the detritus from which is carried down to the navigable part of the river and there deposited, causing shoals. This action continues long after the subsidence of the floods, as was indicated after the flood of the spring of 1891, by the water of the river continuing to be muddy during the whole summer.

A source of snag deposit in the past has been due to the farmers, who, in clearing new land, would fell the timber and allow it to be swept at high water into the stream, where it would lodge. This practice has been checked or altogether stopped by warnings given that it was in violation of law. The sections of the law relating to this subject were, by request, willingly published in the local newspapers.

Respectfully submitted.

R. S. LITTLEFIELD, *Overseer.*

Capt. THOMAS W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following information relative to the commerce of the upper Coquille River, between Coquille City and Myrtle Point, for the fiscal year ending June 30, 1895, has been collected by Capt. R. S. Littlefield, in local charge of the works on that river.

The commerce of the Upper Coquille was accommodated continuously during the fiscal year by the steamboat *Myrl*, of 7.43 tons capacity, making round trips daily between Myrtle Point and Coquille City, and the steamboat *Alert*, 58 tons capacity, making round trips daily between the same points during July, August, September, October, and part of November, 1894, and occasional round trips of the steamboat *Dispatch*, between Bandon and Arago, after hay, etc. The regular route of the *Dispatch* is on the lower river, and these were special trips.

River traffic, Coquille City to Myrtle Point.

Description of freight.	Up trips.	Down trips.
	Tons.	*Tons.*
General merchandise, machinery, etc	806	.....
Butter	.....	74.38
Cheese	.....	23.76
Wool	.....	35
Bacon	.....	30
Live hogs	.....	50.08
Apples	.....	40
Potatoes	.....	100
Barley	.....	75
Oats	.....	25
Hay	.....	50
Milk for creameries	.....	100
Total	806	603.22

Total freight carried, 1,409.22 tons; estimated value, $120,000.

INDUSTRIES.

Product of creameries.

Arago Creamery:

38 tons butter	$15,200
21 tons cheese	3,780
21 tons live hogs	2,100
6 tons dressed hogs	600
1 ton bacon	185

Sheet A.

IMPROVEMENT OF COQUILLE RIVER.

Map of COQUILLE RIVER, Oregon From Coquille City to Myrtle Point.

Showing Shoals and Channel Depths.

From Survey made by David B. Ogden, Asst. Engr., Nov. 1894.

Scale.

To accompany annual report for 1895 of Captain T. W. Symons, Corps of Engineers, U.S.A.

NOTE.

All soundings are expressed in feet and are reduced to the extreme low river stage at time of low tide.

Four foot Curve indicated thus .....

COQUILLE CITY

Saw Mill

Wharf

Fox Orchard

Steveson's L'dg.

Orchard

Selff's L'dg.

Coquille Creamery

Hog Yard

Roy's L'dg.

School House

Willard's L'dg.

Liard's L'dg.

Orchard

Pope Ferry

Norris Saw Mill

Orchard

Wright's

Butler's L'dg.

Fish Trap L'dg

J.J. Lamb's

Meadow

ARAGO

Schroeder's Store & P.O.

Creamery

A. Roots L'dg.

Hatter's L'dg.

Clinton's

Nancy's Pinch

Shoal No 7.

Smith's L'dg.

Leg's Side

Dunlap's

Orchard

Orchard

Barklow's L'dg.

McCloskey's L'dg.

Moomaw's L'dg.

Reed's L'dg.

Shoal No 6

Shoal No 5

McCloskey's Store & P.O.

NORWAY

Carl's L'dg.

Shoal No 4.

Butler's

Willows

ROBERT'S LANDING

Schroeder's L'dg.

Orchard

Mayer's L'dg.

Derorit L'dg.

Shoal No 3

Shoal No 2

Shoal No 1

Roseliff's L'dg.

Saw Mill

Flour Mill

NORTH FORK

Old Meander Line

Quarry

Quarry

Hazen Road

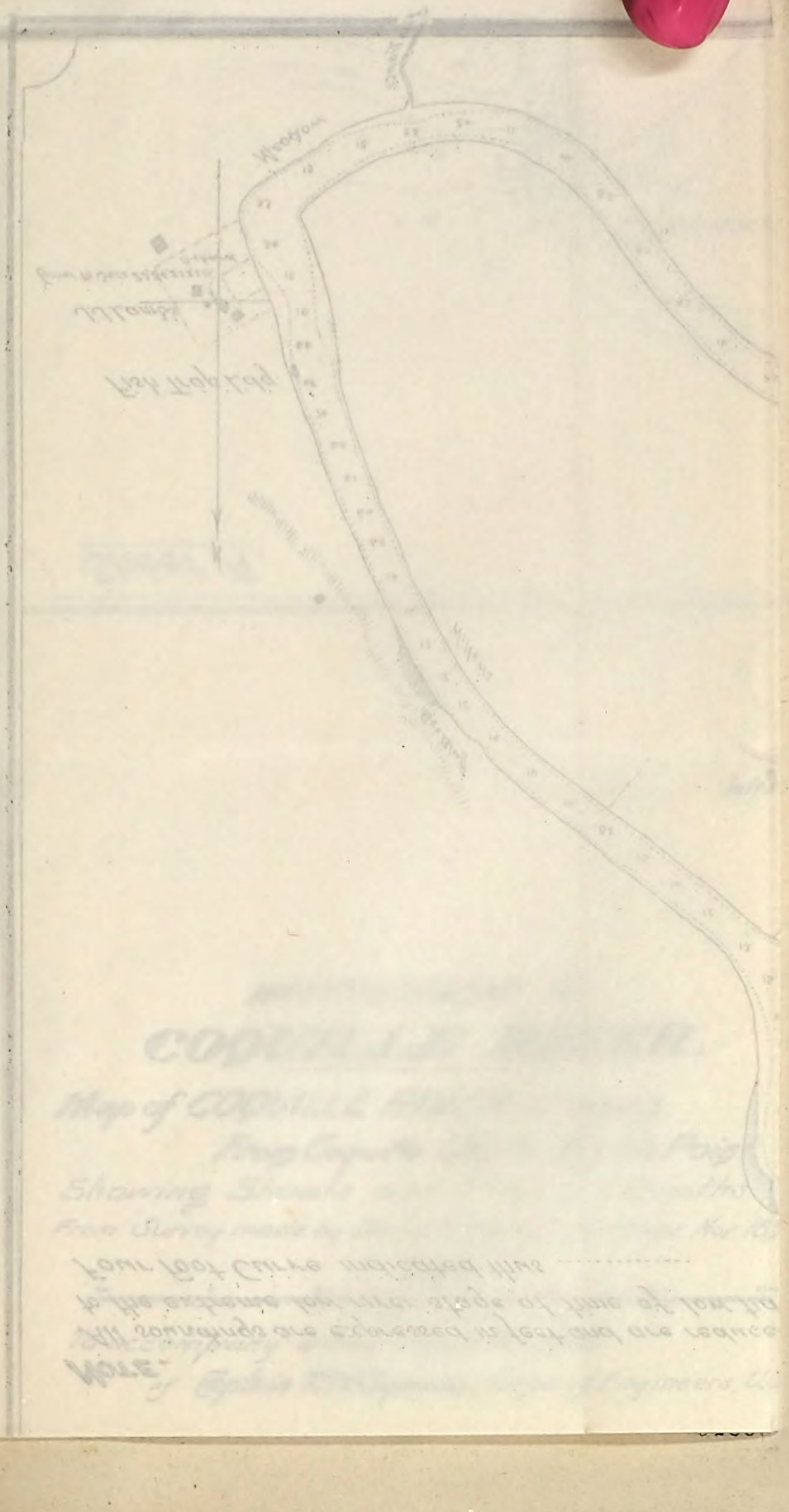
Creamery

Dwell

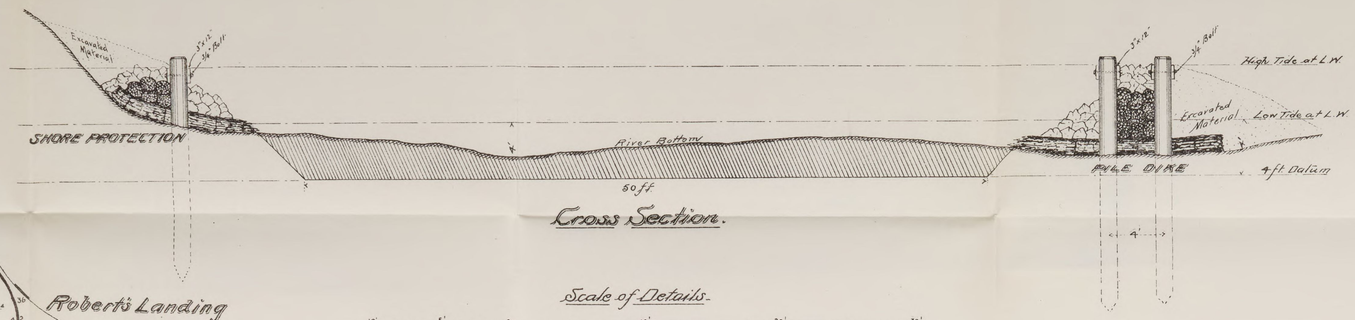
Saw Mill

MYRTLE POINT

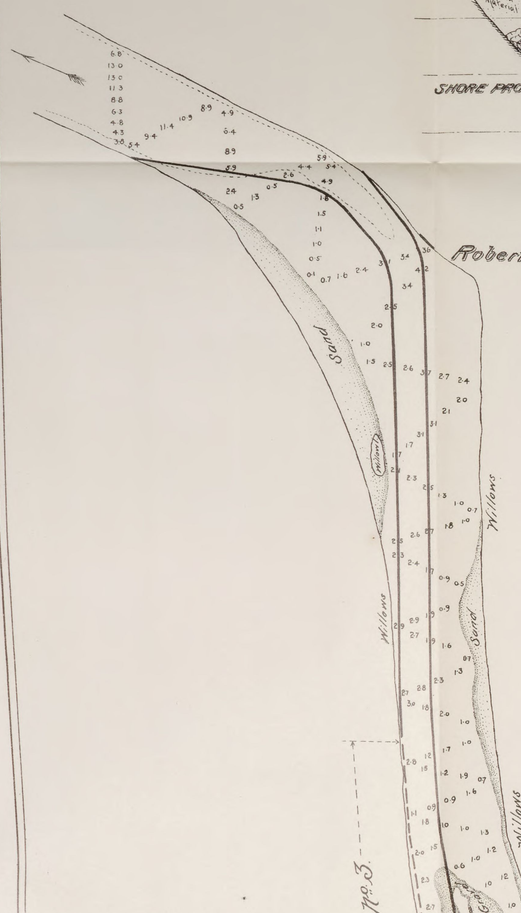
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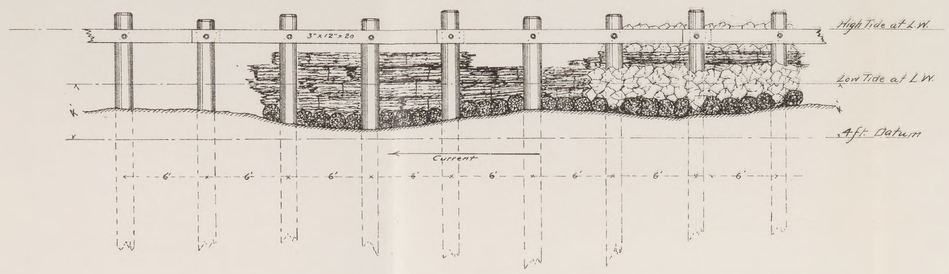
Sheet B.



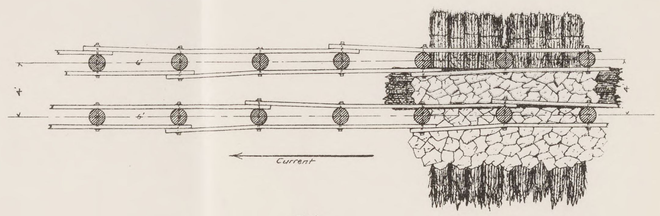
Cross Section.



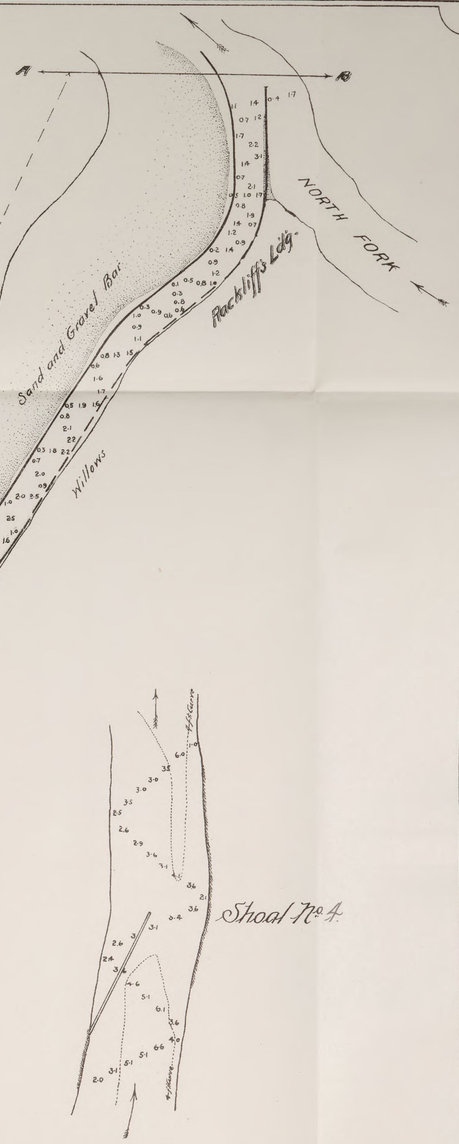
Scale of Details

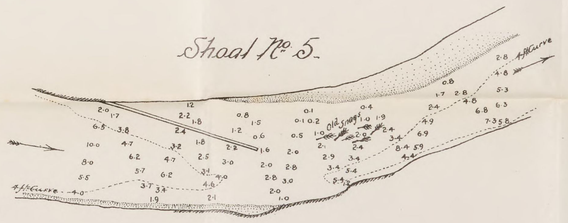


Front Elevation



Plan.

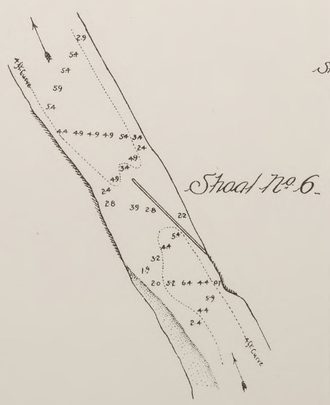


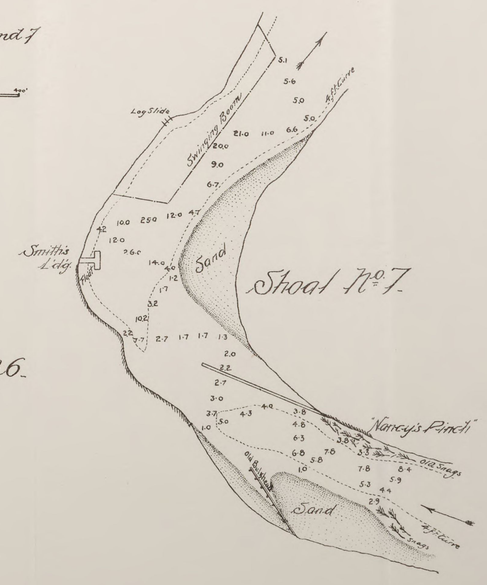


NOTE-
All soundings are expressed in feet and are reduced to the extreme low river stage at time of low tide.
Four Foot Curve indicated thus .....
Existing Brush & Stone Dams " "
Proposed " " "
" " " Riprap " "
" Pile Dike " "
" Shore Protection " "

NOTE-
The locations of Shoals 4, 5, 6 and 7 are as shown on Sheet A.

Scale-





IMPROVEMENT OF COQUILLE RIVER.

Map showing obstructions to navigation between Coquille City and Myrtle Point with location and details of proposed improvements.

From Survey made by David B. Ogden, Asst Engr, Nov. 1894.

Scale of General Plan.

To accompany annual report 1895 of Captain T.W. Symons, Corps of Engineers, U.S.A.

Coquille Creamery:	
31.5 tons butter	$11,250
24 tons live hogs	2,400
Mrytle Point Creamery:	
5 tons butter	2,000
3 tons cheese	660
5 tons live hogs	500
Gravel Ford Creamery, not in operation.	
Total value	38,675

Besides the milk delivered during the season to the creameries by steamboat, a large amount is delivered by rowboats and in other ways, the small steam launch *Maria* and the gasoline boat subsequently used with the Government snag boat having been so employed during part of the season.

When in the immediate neighborhood of the creameries farmers deliver their milk by wagon; the bulk of it, nevertheless, reaches its destination by the river.

From data furnished by superintendents of creameries, it takes 24.875 tons of milk to make 1 ton of butter and 10 tons of milk to make 1 ton of cheese.

New industries.—At Myrtle Point a yard has been established for the manufacture of brick and tiles, the former for local supply and the latter for use in draining lands adjacent to the river.

The output of this yard for the time it has been in operation is as follows:

	Estimated value.
500,000 brick	$4,500
100,000 linear feet tiles	5,000
Total	9,500

Summary.—Total river freight, 1,409 tons; estimated value, $120,000; total number of river passengers, 2,050. The value of the creameries' output, $38,675, is included in the above summary.

T T 3.

IMPROVEMENT OF ENTRANCE TO COOS BAY AND HARBOR, OREGON.

Description of original condition.—The obstructions which existed at the entrance to this harbor before the works of improvement were begun consisted, first, of the outer bar, which is of sand and is shifting in character; and, second, of the inner shoals formed by the sands which accumulate in the spring, summer, and autumn, during the times when the northwesterly winds prevail.

Under the action of these winds the spit on the north side advanced toward the south, contracting the navigable passage under Coos Head to a very narrow width, and usually making the outer channel follow the west side of the spit in a long and tortuous course across the bar.

The channel had at times broken through the north spit on a line the general direction of which is from Fossil Point to a point just to the north of Coos Head. It was then direct, the depth of water was greatest, and vessels could enter or go out without trouble. The mean rise of the tide above the plane of reference was 5.6 feet.

Plan of improvement.—The project for this improvement, adopted in 1879, was to construct at an estimated cost of $600,000 a jetty of wood and stone, as might be found best, from a point 250 yards below the northern extremity of Fossil Point on a line toward the east end of Coos Head, this line in plan curving so as to be directed at its outer end to the head or a little to the north of it.

The object was to prevent accretion to the south end of the sand spit on the north side of the entrance, and to open and maintain a deeper and more direct channel across the bar.

The present plan, adopted in 1889, under which operations are progressing for the improvement of the entrance to Coos Bay, consists in the abandonment of any further work on the Fossil Point Jetty and the building of two high-tide jetties of stone, one from Coos Head and one from the southern end of the north spit out toward the bar, ending at a distance apart of about 1,500 feet.

In addition to this, the project includes the reclamation and holding of the sands of the north spit, to prevent as far as possible their blowing over into the harbor.

The estimated cost of the work as approved is $2,466,412.20.

APPROPRIATIONS.

Under old project of 1879:	
Act of—	
March 3, 1879	$40,000
March 3, 1881	30,000
August 2, 1882	30,000
July 5, 1884	30,000
August 5, 1886	33,750
August 11, 1888	50,000
Total	213,750
Under new project of 1889:	
Act of—	
September 19, 1890	125,000
July 13, 1892	210,000
August 17, 1894	95,000
Total	430,000
Aggregate	643,750

Amount expended to June 30, 1894.—The total amount expended in improving the entrance to Coos Bay to June 30, 1894, was $540,794.13. Of this amount $213,750 was expended on the old project and $327,044.13 on the new project.

Results obtained to June 30, 1894.—The work of construction was confined to the North Jetty. The tramway was extended during July, 1893, a distance of 288 feet, when it was stopped. The total length of the tramway was 9,520 feet. This was mattressed throughout with center and side mattresses.

The work of enrocking the jetty was carried on throughout the year, and a total of 117,340.7 tons of rock were placed.

During the summer and fall of 1893 the depth on the bar remained about as usual before improvement, about 16 to 20 feet at high water.

During the winter, as the enrockment slowly grew, a marked change took place in the bar channel, and a depth of 28½ feet at ordinary high water was attained. A bar depth of 24 to 28 feet has been maintained ever since.

On June 14, 1894, Mr. Polhemus, on the *Wright*, made a survey of the bar channel. This indicates an excellent direction to the channel and a minimum depth of 20 feet at the mean of the lower low waters.

Amount expended during fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $98,593.16.

Results obtained during fiscal year ending June 30, 1895.—The jetty tramway was extended to its full length of 10,368 feet, an extension during the fiscal year of 848 feet. It was mattressed throughout, and during the year there have been placed upon it 97,847.9 tons of stone. In addition, 1,611.8 tons of small rock were placed at the root of the jetty to prevent scour.

The construction of the jetty has had a marked and very beneficial effect on the entrance channel, maintaining it in a fixed position and with a bar depth of 18 to 21 feet at low water. Never before in the history of the bay have such depths been maintained continuously throughout any year.

On June 1, 1895, an examination of the bar was made by Mr. Polhemus, who, on the *Wright*, ran two lines of soundings across it. He found in the channel a minimum depth of 20 feet at the mean of the lower low waters. The channel runs close to the end of the jetty, and thence in a straight line seaward nearly on line with the work, the very best water trending slightly across its axis to the northward. Upon the map herewith the soundings made June 1, 1895, are indicated by underscoring. Other soundings are from former surveys.

The high and low water lines about the south spit as shown are plotted from surveys made during May, 1895.

There is no record of a less bar depth than 18 feet at mean lower low water since November, 1893. When it is considered that previous to this time bar depths of 10 and 12 feet were very common, the success of the work so far done is made very apparent.

Report of operations.—At the beginning of the fiscal year work was in progress in extending the jetty tramway with the remainder of the appropriation of 1892. During July 144 feet of tramway were built. In preparation for future work the plant was overhauled and put in order; the stone and brush scows were hauled out, scraped, calked, and painted, and the cars, locomotives, and hoisting engines were put in order.

During August the jetty tramway was completed to its full length by adding 704 feet to it, and a side track 200 feet long, for the enlargement of the jetty head, was built. As the tramway was built the mattresses followed.

It was deemed necessary to push the work of tramway extension and mattress work during the quiet weather of summer so that the work of enrockment could go on during the winter.

As the fall progressed and the seas became more troubled, greater difficulty was experienced in sinking mattresses, and it was found necessary to reduce the thickness of the mattresses from 5 feet to 3 feet, in order to get them down without too great loss. The old method of sinking them by loading them with stone dumped on top of them had to be abandoned, and it was found necessary to incorporate enough stone in them to sink them. This added somewhat to the expense.

On September 6, 1894, bids were opened for furnishing stone for the work to be done with the new appropriation of $95,000.

The following is a summary of the bids received:

No.	Name and address of bidder.	Per net ton.	Total.
		Cents.	
1	R. A. Graham, Marshfield, Oreg	90	$27,000
2	Daniel Kern, Portland, Oreg	63	18,900

The contract for furnishing the stone was awarded to Daniel Kern at 63 cents per ton, delivered on board scows at the Government wharf at the root of the jetty. During the year 94,847.9 tons were delivered under this contract, and 3,000 tons were purchased in open market at 70 cents per ton before the contract was let.

During the late winter of 1894–95 an erosion of the bank near the root of the jetty commenced, threatening to undermine some of the buildings. To stop this the bank was revetted with brush and small stone procured from the contractor at a reduced price of 50 cents per ton. The erosion was effectually stopped by this means. Some of this small stone was also used to build up the groins near the receiving wharf.

A longitudinal profile of the jetty enrockment is herewith. It shows that the entire enrockment has been raised to above average low-water level, except at the extreme outer bents.

Upon the profile is shown by dotted lines the top of the enrockment one year ago (June 15, 1894).

A sliding ways was constructed just south of the wharf at the north spit where the floating plant was hauled out and scraped, repaired and painted, and the decks sheathed.

When the tramway extension was completed, an attempt was made to ascertain the depth of sand, and to this end a pipe was jetted down to a depth of 93 feet below the plane of the lower low waters. This was the limit of the appliances and throughout nothing but sand was encountered. The report of Mr. J. S. Polhemus, which is herewith, gives in a clear form the details of operations.

Recommendations and remarks.—The north jetty has been partially completed for its entire length. The work remaining to be done is to add sufficient stone to the enrockment so that it can be left with a reasonable probability of its remaining at full high tide. This involves special appliances and special care in completing the outer portion for about 1,000 feet.

The outer end of the jetty is in deep water and is exposed to very heavy wave action, and it is found impossible to maintain it above low water, as it is at present built by dumping stone into a random heap. The tramway is 28 feet above the surface of low water, the stone used is not very hard, and it is found that in dumping the heavy stones of 5 to 13 tons weight they are sometimes broken and sometimes break those upon which they fall. These smaller pieces are still less able to resist the wave action than the large ones would be. The result of it all is that the last 1,000 feet or more of the jetty is continually being beaten down and flattened out. Inside of this, the present method of dumping does very well. It is proposed in another year to make special arrangements for building up the outer portion. The method now deemed most practicable is to convert the revolving pile driver into a track derrick, or to otherwise construct a track derrick, and with it to carefully place the largest stones capable of being handled with our machinery. In this way it is hoped that the outer end of the jetty can be built up so as to be reasonably permanent at about the elevation of high tide.

It will be advisable to build about eight groins from 100 to 300 feet in length each, for the protection of the enrockment against racing undermining currents.

The map herewith shows how closely the entrance channel is hugging the jetty, and this action seems to be continuous and to demand the construction of protecting groins at the earliest possible date.

All this work of completing the jetty and the protecting groins should be done while the existing tramway is in good condition; otherwise its cost will be enormously greater. The life of such a structure as this pile and-timber tramway is very limited, exposed as it is to the teredo and limnoria and the storms and waves of the ocean. It is estimated

that to fully complete this north jetty it will cost about $450,000, and it is earnestly recommended in the interest of economy that this money be made available at the earliest date practicable.

The work on the south jetty should also be commenced and carried to completion at the earliest date practicable, as the north jetty is only one of a pair, and can not develop its full usefulness without the aid of its partner on the south.

A comparison of the commercial statistics of Coos Bay with those of former years shows that the exports of its principal products, coal and lumber, have increased. New coal mines have been opened, and coal of a higher grade than formerly is now being mined.

An appropriation of $600,000 is recommended as the amount which can be profitably expended on the project during the next fiscal year.

Future operations.—Future operations will depend upon the amount of money available. The north jetty should be fully completed before it is left for work on the south side. If the money appropriated is but enough to complete this north jetty it would all be expended thereon. If enough to more than complete it, work could profitably be started on the south side.

Money statement.

July 1, 1894, balance unexpended	$7,955.87
Amount appropriated by act of August 17, 1894	95,000.00
	102,955.87
June 30, 1895, amount expended during fiscal year	98,593.16
July 1, 1895, balance unexpended	4,362.71
July 1, 1895, outstanding liabilities	475.00
July 1, 1895, balance available	3,887.71
Amount (estimated) required for completion of existing project	2,036,412.20
Amount that can be profitably expended in fiscal year ending June 30, 1897	600,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. J. S. POLHEMUS, ASSISTANT ENGINEER.

EMPIRE CITY, OREG., *June 6, 1895.*

CAPTAIN: I have the honor to submit the following report of operations on the work of "Improving the entrance to Coos Bay and Harbor, Oregon," for the fiscal year ending June 30, 1895:

The beginning of the fiscal year found a small force renovating and putting in repair the plant, with the remnant of the preceding appropriation.

Repair of plant.—A sliding way was constructed just south of the wharf at North Spit, and all the scows, including those borrowed from the Siuslaw, were hauled out, scraped, repaired, painted, and the decks resheathed.

The work lasted until October 1, 1894, which was after active operations were resumed.

Ten large scows and four smaller ones were hauled out and put in good order, at a total cost of $2,973.33.

A new set of tires was put on the locomotive Yarrow, replacing the old ones, which had become deeply grooved by three years of continued service on the curved track.

The pinion on the crank shaft of the oldest wharf hoisting engine was renewed, and all the principal journal boxes rebabbited.

All of the cars were scaled, scraped, and repainted, and minor repairs were made to the entire plant, putting it in first-class order.

A diver was employed for four days in June, 1894, and 18 car loads of rock, which had fallen from the scows by accident at various times were grappled up from in front of the North Spit receiving wharf.

This same work was attempted in May, 1895, at the end of the present work, but only three large rocks were taken up, owing to the leaky condition of the diving suit.

During the year the woodwork of the stone cages was renewed. No additions were made to the plant, and it consists now, as formerly, of 1 revolving-track pile driver, with 10 by 6 by 10 inch Worthington steam pump; two 11-ton Baldwin locomotives, 20 geared dumping cars, 6 flat cars, 2 mattress cars, 4 push cars, 1 hand car, 2 large Lidgerwood hoisting engines, two 15-ton wharf derricks and rigging, 1 towboat (*Gen. H. G. Wright*), 7 large rock scows, 3 large rock scows borrowed from the Siuslaw, 4 smaller scows for brush and lumber, one 12-foot æromoter pumping windmill, besides small boats, anchors, chains, jackscrews, tackles, hose, and all the necessary tools and appliances needed for carrying on the work in an expeditious manner.

It would cost a sum not far short of $75,000 to replace it.

Active operations.—The resumption of active operations may be said to date from July 24, 1894, when the jetty pile driver was hauled to the front and the work of building the tramway again continued, slightly in anticipation of the expected appropriation.

The approved act of Congress appropriating $95,000 was passed in August 1894, and the work of first extending the tramway, and then brushing and enrocking the jetty continued without interruption until the end of May 1895, by which time the available funds being nearly exhausted, the work had been shut down and the plant stored away.

At the close of work a rough shed 240 feet long was built over one of the spur tracks to protect the cars while out of use.

The rock was furnished by contract, and all other materials and supplies bought in open market, or on bids after circular notice inviting proposals.

The work of receiving and handling the materials and of building the north jetty was done by hired labor, the men working but eight hours per calendar day as required by law, and many being subsisted by the Government at the works.

The average cost of a ration for the year was 43.15 cents, including cooks, wages, and fuel.

Extension of jetty tramway.—This work was commenced July 24, and the jetty tramway was extended 54 trestle bents to No. 648, the projected end of the north jetty, a distance of 848 feet.

In addition, a parallel spur was built on the north side for the outer 200 feet, with its center 13 feet from the center of the north track.

This enabled us to sink an extra 20 feet width of mattress for that length, giving a brush foundation 80 feet wide and a broader base at the end, where greater security is required against the scour of the currents and the heavy breakers.

The depth of water throughout this extension varied from 20 to 22 feet at mean lower low tide. The piles used were of fir, 16 to 20 inches in diameter at the butt end, and from 78 to 80 feet long. They were hydraulicked into the sandy bottom not less than 30 feet.

The tramway was built as described in previous reports, four piles to the bent, the bents spaced 16 feet apart, and capped with 12 by 12 inch fir timbers 22 feet long, driftbolted at each pile with $1\frac{1}{8}$ by 22 inch round iron bolts; each pile was further secured by a strap of $\frac{3}{8}$ by $2\frac{1}{2}$ inch flat iron, passing over the cap and spiked to the top of the pile.

The double track rested on longitudinal stringers 12 by 16 inches by 32 feet, fastened to the caps with 1-inch round iron driftbolts.

The gauge of the track is 3 feet, and the distance between them is 13 feet; the rails are of steel and weigh 30 pounds to the yard.

The elevation of the extreme end of the tramway is 28 feet above mean lower low water.

No sway braces are used, but on the outer 1,000 feet 6 by 6 inch struts are inserted between the piles and the caps to the rear, to relieve the driftbolts from the strain caused by the heavy seas.

The extension of the tramway was completed and the pile driver hauled in August 29, the work lasting a little over one month; nearly all the requisite material for its construction had been purchased and paid for the previous year.

The weather was quite favorable but the work was difficult owing to the depth of water and the exposure to the heavy sea, as well as the extreme length of the piles.

Mr. Charles Getty was foreman of the pile-driver. The cost of the 848 feet of the tramway extension and the 200-feet spur was as follows:

Materials: Rails, iron, piles, and lumber	$3,195.24
Labor and subsistence of crew	1,231.50
Total	4,408.74

This does not include general superintendence and office work, nor cost and maintenance of plant.

Before hauling in the pile driver an attempt was made to pump a pipe to the solid bottom to ascertain the depth of the sand deposit at the end of the jetty.

The pipe was jetted down 93 feet below mean lower low water, 72 feet of which distance penetrated the sand. I am not sure that it even then passed through the sand to any material of a different character, but with our appliances that was the limit to which it could be forced.

Brush mattress work.—September 1, 1894, immediately after the completion of the tramway, the work of sinking the foundation brush mattresses commenced.

A center mattress, 3 fascines thick and 20 feet wide, was placed to the end and throughout the 200 feet of spur. Also mattresses of the same dimensions on either side to the end.

They were composed of three layers of fir-brush fascines nearly 1 foot in diameter and 20 feet long, and the center ones were built on grillages of fir poles suspended from the track stringers. When finished they were lowered to the water and sunk with small rock.

The side mattresses were built on special cars, from which they were tipped to the water on the side of the jetty, and, while held in place by four lines, sunk by small rock thrown on by hand.

Much difficulty was experienced in sinking the mats on account of the depth of the water and the roughness of the sea. This was overcome in the case of the center mats by weighting them with a carload of small rock to the bent, incorporating it into the structure of the mattress while building, thereby nearly overcoming the buoyancy of flotation, and permitting a very little extra rock to rapidly and evenly settle them to the bottom, where they were quickly loaded with larger blocks.

We were rather late in commencing the work, as the heavy swell sets in generally after October 1, consequently the work was interrupted considerably, and dragged on to November 17 before completion.

We used 1,070½ cords of fascines, purchased in open market, at $1.90 per cord free on board our scows, which were towed to the works by our towboat the *General Wright*. Also 2,359 fir poles, bought in the same way, at 17½ cents apiece.

In lashing the mattresses about 50 coils of 12-thread manila rope was used, besides over a ton of old worn-out rope.

We laid 1,040 linear feet of center mattresses and 1,693 linear feet of side mattresses, besides 196 linear feet of extra center mattresses placed on top of the enrockment in a low place to use up a remnant of brush left over.

We lost 288 linear feet of mattresses in sinking during the season. The center mattresses were usually built in lengths of three trestle bents.

The cost of the above mattress work, not including the cost of general superintendence, nor cost and maintenance of plant, was—

Materials	$2,547.05
Labor and subsistence, towing and unloading	1,876.28
Total	4,423.33

Jetty enrockment.—To expedite work and get the mattresses down before the storms of fall should render it impossible, 3,000 tons of rock was purchased from Daniel Kern in open market, at 70 cents per ton, as he had his derricks and engines in place in the old quarry. He delivered the first scow load August 30.

September 24 he signed a contract to deliver 30,000 tons, or more, of large-sized rock, at 63 cents per ton of 2,000 pounds, delivered at the jetty wharf on Government scows.

He delivered under the contract 94,847.9 tons; also 1,611.8 tons of one-man rock at 50 cents, used for shore revetment and groin enrockment, making a total of 99,459.7 tons; all but about 3,000 tons was dumped by hard labor on the outer 848 feet of tramway extension, including spur.

For the transportation of the first 3,000 tons and the contract rock (94,847.9 tons), it required 366 scow loads, averaging 267.13 tons to the load.

All the rock was measured by scow displacement.

In unloading it four men were used on each scow. It was hoisted up with two derricks, an engine tender, and three men to each.

Two locomotives and twenty dumping cars carried it out on the tramway, where it was dumped to place by the single brakeman on each train.

One man patrolled the track constantly to keep it in order, and a carpenter and a blacksmith and helper were employed in keeping the plant in good repair.

The specifications called for rock of the following description, viz: "The blocks must be angular and as nearly cubical as practicable, the longest dimension not to exceed 9 feet; one-fourth of the weight of each scow load must be in blocks weighing at least 4 tons, and not exceeding 10 tons each, one-half in blocks averaging 2

tons each, and one-fourth in blocks weighing not less than 1,000 pounds. These proportions may be changed as the engineer officer in charge may direct."

They were followed as closely as practicable. During the sinking of the mats some smaller rock was used. The largest piece dumped weighed about 17 tons, and one scow load weighing 303 tons contained but 33 pieces of rock; but this was exceptional.

The expense of loading and dumping to place, exclusive of general superintendence and cost and maintenance of plant, was 10½ cents per ton.

As much as 800 tons was unloaded in eight hours with the two derricks.

The enrockment is all raised to above average low-water level, except at the extreme outer bents. (See accompanying profile.)

At the outer 1,000 or 1,500 feet it is found difficult to raise the enrockment much higher than average low-water level, as the force of the seas beat it down and roll off the rock of the dimensions used.

The sandstone rock in being dumped from such a height also breaks up to a great extent into smaller blocks as the big pieces strike each other. In the future I think it would be advisable to rig some description of crane to lower even larger blocks carefully to place for the outer quarter of a mile. It would also be desirable if a harder quality of rock could be found available for this portion, but I do not know of any in the vicinity.

Quarry operations.—The rock was supplied from the Rogers quarry on South Coos River, 1 mile above the forks and 19 miles from the works.

It is a rather soft gray sandstone, of a specific gravity of 2.35. Mr. Daniel Kern, the contractor, worked 4 derricks and 1 cable way for the removal of débris, employing 5 hoisting engines. His crew numbered from 40 to 60 men. He towed the scows to and from the jetty with the small propeller *Tonquin*.

The quarry turned out very well, and is capable of supplying more than enough to complete the north jetty.

For the removal of the débris the contractor installed a cable way high up across the face of the lower pits, and ran the earth and the small rock to the dump in the neighboring gulch, but the greater part was removed by scows and used to revet the river banks.

The lower part has a great deal of good rock blasted out, a heavy seam shot throwing down much more than the contractor needed at the last. Maj. Morton Tower was the Government inspector at the quarry.

One serious accident occurred at the quarry November 15, resulting in the death of Mr. J. G. West, the contractor's foreman, and Terrence Dolan, workman, who were fatally burned by the accidental explosion of 27 kegs of black powder.

Reclamation of sand dunes.—No work of this nature was done throughout the fiscal year, but the holland grass transplanted from the Golden Gate Park continues to grow and spread. All other plants which we have transplanted or sown have died.

Groins and shore protection.—During the winter quite a scour of the bay beach above the north spit wharf was observed, which threatened some of the buildings as well as injury to the wharf from the deposit of eroded sand, consequently 6½ scow loads of one-man rock and quarry spawls, measuring 1,611.8 tons, were purchased from Mr. Kern to revet the beach, and also to raise the enrockment of the lower groin to the height of average low tide.

These works appear to have effectually stopped the trouble.

Miscellaneous.—A crew of from 30 to 55 men, all told, was employed at the jetty; laborers were paid $2 per day, or $1.50 per day and subsisted.

Mr. John W. Eldridge was the overseer, and Mr. Morton L. Tower timekeeper and receiver of materials, and assisted in surveying and office work. To them as well as to all the crew I am indebted for faithful services during the year.

No accidents occurred at the works, although one man (Glen Cox) was drowned while crossing the bay from town in a small boat March 21, 1895.

Coos Bay coal was used as fuel, at a cost of $2.50 per long ton, free on board our scow at the bunkers. We bought 491 tons from R. A. Graham in the fiscal year, and have a little more left on hand than we started with.

We used 207 ricks of engine and stove wood, at a cost of $1.30 to $1.50 per rick, besides 63 cords of mill wood for fuel for the *Wright*, the latter costing $1.50 per cord.

Since the *Wright* was laid up, the steamer *Comet* was chartered to make two trips per day from Empire to the works, for a price of $99.75 per month, to carry supplies and passengers.

The work ceased May 31, 1895.

The steamer *Tonquin* towed two of the large scows to Siuslaw for Mr. Kern on June 1.

Repairs of steamer Gen. H. G. Wright.—The steamer *Wright*, which was used to tow the brush and poles and to bring other supplies to the works, broke her shaft and lost her propeller in Coos River November 22. The boat was laid up for several

months, as the boiler was leaking and the machinery and hull very much out of repair, but little work having been done on the vessel since she was built, in 1879.

In accordance with your instructions of January 8, 1895, to put the steamer in first-class order, not to exceed $3,000, the hull was hauled out on the ways at the North Spit, after removing the machinery, and the boiler shipped to Portland, where it received a large patch on the bottom and a new set of tubes. A new end section of shaft was bought and the engine and machinery cleaned and repaired. All the decayed wood in the vessel was replaced with sound timber, necessitating a new rudder, masts, and bowsprit, and several new timbers, planks, and much ceiling.

The greater part of the copper sheathing was renewed, and the boat calked and painted and put in first-class order.

But a small force worked on the vessel, and the repairs were not completed until June 1, when she was dispatched to Yaquina Bay to make a survey of the bar.

Commerce.—The Beaver Hill Coal Company opened a new coal mine during the year in the Beaver Slough Valley, near the line of the C. B. R. & E. R. R. & Nav. Co., and 13 miles from Marshfield, where they have built a new bunker, and have chartered the steamer *Homer* (433.86 net tonnage) to carry the coal, which proves to be of excellent quality.

Goodall, Perkins & Co. operated the Newport coal mine as usual, carrying their product to San Francisco in the steamers *Arago* and *Arcata*.

The steamers *Alice Blanchard* and *Bandorille* make regular trips to Portland, and appear to be developing considerable trade.

The C. B. R. & E. R. R. runs regular trains between Myrtle Point and Marshfield, and is making preparations to extend the track eastward to Roseburg.

All of the sawmills on the bay were operated more or less, except that of the Porter Company.

One large barkentine of 556 tons, (the *Omega*) was launched at North Bend in October, and sailed for Chile with 700,000 feet of lumber.

Another large vessel is on the stocks at the same mill yard, now in process of construction.

The small stern-wheel steamer *Alert* has lately been put on the Coos River route, making four small steamboats there. Three steamboats ply on the bay between Marshfield and Empire.

General results obtained, condition of the bar, etc.—Work has been in progress on the north jetty under the project of 1889 since the spring of 1891, and the tramway has been constructed to its projected length and all of the mattress work finished; much of the enrockment has been completed, so that nowhere, except at the extreme end, is the crest of the dump below ordinary low-tide level, and for a greater part of its length it is above high tide.

On June 1 last I made an examination of the bar with the steamer *General Wright* and located two lines of soundings across it.

The ship channel runs close to the end of the jetty, the best waters trending slightly across its axis to the north.

The minimum depth found was 20 feet at mean lower low water. I found the south spit well crowded toward the jetty, and the deep water in the entrance lies close along the jetty for at least a quarter of a mile, being from 5 to 6 fathoms at mean lower low water.

From examinations, and from the reports of the masters of the tugs and other vessels, I have not heard of less than 18 feet minimum depth at mean lower low water on the bar since November, 1893, although for the first two years of new work I have known at times of as little as 10 feet at the same stage of tide.

During the past year there have been very few detentions of vessels, and some of deeper draft than formerly have been taking cargoes from this port.

Among the more important changes due to the work, I would mention the vast accumulation of sand which has occurred to the north of the jetty, advancing the high and low water shore lines, as can be seen by the accompanying map.

The point of the north spit inside the jetty and opposite South Slough and Charleston appears to have cut away considerably, and this action seems to be continuing.

Since work closed I have noticed a marked settlement of the enrockment for the outer ten trestle bents.

Summation of work since 1890.—The following are the principal items of work accomplished on the north jetty under the 1889 project since 1890.

An extensive and efficient plant for building the jetty has been purchased and installed, including the construction of the necessary wharf, buildings, gridirons, platforms, side tracks, and other accessories for the convenient and rapid execution of the work.

The jetty tramway has been extended to its full projected length of 648 trestle bents, or about 10,368 feet from the receiving wharf.

All the mattress work on the north jetty has been completed. It consumed 7,045 cords of brush fascines and 13,331 poles, and comprises 4, 864 linear feet of jetty cen-

ter mattresses, 5 layers of fascines thick by 20 feet wide; 280 linear feet groin center mattresses, 5 layers of fascines thick by 20 feet wide; 4,400 linear feet of jetty center mattresses, 3 layers of fascines thick by 20 feet wide; 9,312 linear feet of channel-side mattresses, 3 layers of fascines thick by 20 feet wide; 2,912 linear feet of seaside mattresses, 3 layers of fascines thick by 20 feet wide; 760 linear feet of shore-protection mattresses, 3 layers of fascines thick by 20 feet wide.

A good quarry site on Coos River has been acquired by purchase. We have received and used on the north jetty to date the following quantities of rock:

	Net tons.
From W. E. Baines, contract (91 and 92)	23,923
From Daniel Kern, contract (93 and 94)	161,869
From John Kiernan (one-man rock) (93 and 94)	981
From Daniel Kern, contract (94 and 95)	97,848
From Daniel Kern (one-man rock) (94 and 95)	1,612
Total	286,233

This has been accomplished under three appropriations under the 1889 project, viz:

By act approved September 19, 1890	$125,000
By act approved July 13, 1892	210,000
By act approved August, 1894	95,000
Total	430,000

This amount has built so much of the north jetty that it is evident that its final cost when completed will be as much as 40 per cent less than the original estimate of $1,281,987, plus 20 per cent for contingencies.

It is impossible to calculate accurately the further quantity of rock required, on account of our ignorance of settlement and spreading which may take place, but for a rough estimate I should say it should not much exceed that already used, or, say, 300,000 tons, and as the necessary plant is on hand and the whole tramway and mattress work finished, and as the 286,233 tons of rock placed, divided into the total money appropriated, makes the cost of the riprap to date $1.50 per ton, I think it safe to assume that 300,000 tons more could be placed for $450,000, even after making a liberal allowance for the employment of much larger pieces on the outer portion.

This work could be done in one year if sufficient funds were available.

I should judge that nearly half of the life of the perishable tramway and plant has expired, and it is very important that the balance of the enrockment be placed and the north jetty completed while they are in good order.

The following sketches accompany this report, viz:

Map showing plan of jetty and shore line.

Profile of north jetty enrockment to date.

Very respectfully, your obedient servant,

J. S. POLHEMUS, *Assistant Engineer.*

Capt. THOMAS W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Coos Bay is in the collection district of southern Oregon. Empire City, on the bay, is the port of entry. The nearest light-house is at Cape Arago, on the south side and west of the entrance.

The following returns relative to the commerce of Coos Bay are compiled from the monthly reports as rendered by Mr. J. S. Polhemus, assistant engineer in local charge of works; they are for the fiscal year ending June 30, 1895:

Arrivals and departures of vessels.

Coastwise steam and sail vessels.	Number.	Aggregate tonnage.
Steam vessels arrived	150	88,330
Sail vessels arrived	999	
Steam vessels departed	157	87,000
Sail vessels departed	98	
Total	513	175,330

Number of passengers arrived by sea	971
Number of passengers departed by sea	963

ENTRANCE TO
COOS BAY, OREGON

SHOWING JETTY CONSTRUCTION TO DATE, ALSO
BAR SOUNDINGS OF JUNE 1st 1895, UNDERSCORED THUS: 27

Scale
ft 1000 500 0 1000 2000 3000 4000 ft.

Soundings are expressed in feet and indicate the depth at the mean of the lower low waters. Mean rise of tide 5.7ft.

Outer Mattress
Constructed Jetty, June 30 1895
Inner Mattress

Sent with annual report for 1895

Captain, Corps of Engineers

True Meridian

OCEAN

North Spit breakers

PACIFIC

South Spit breakers

PROPOSED SOUTH JETTY

NORTH JETTY

L.W. H.W. L.W. (1895) H.W. (1895)

NORTH SPIT
Bare Sand Dunes

Tank
Gov.t Wharf
Groin
Groin

Guano Rock

Coos Head

Tunnel Point

Proposed Wharf

SOUTH SLOUGH

L.W. (approx.) H.W.

Pigeon Pt

Fossil Point

SUBMERGED JETTY
Buoy

PLAN OF IMPROVEMENT

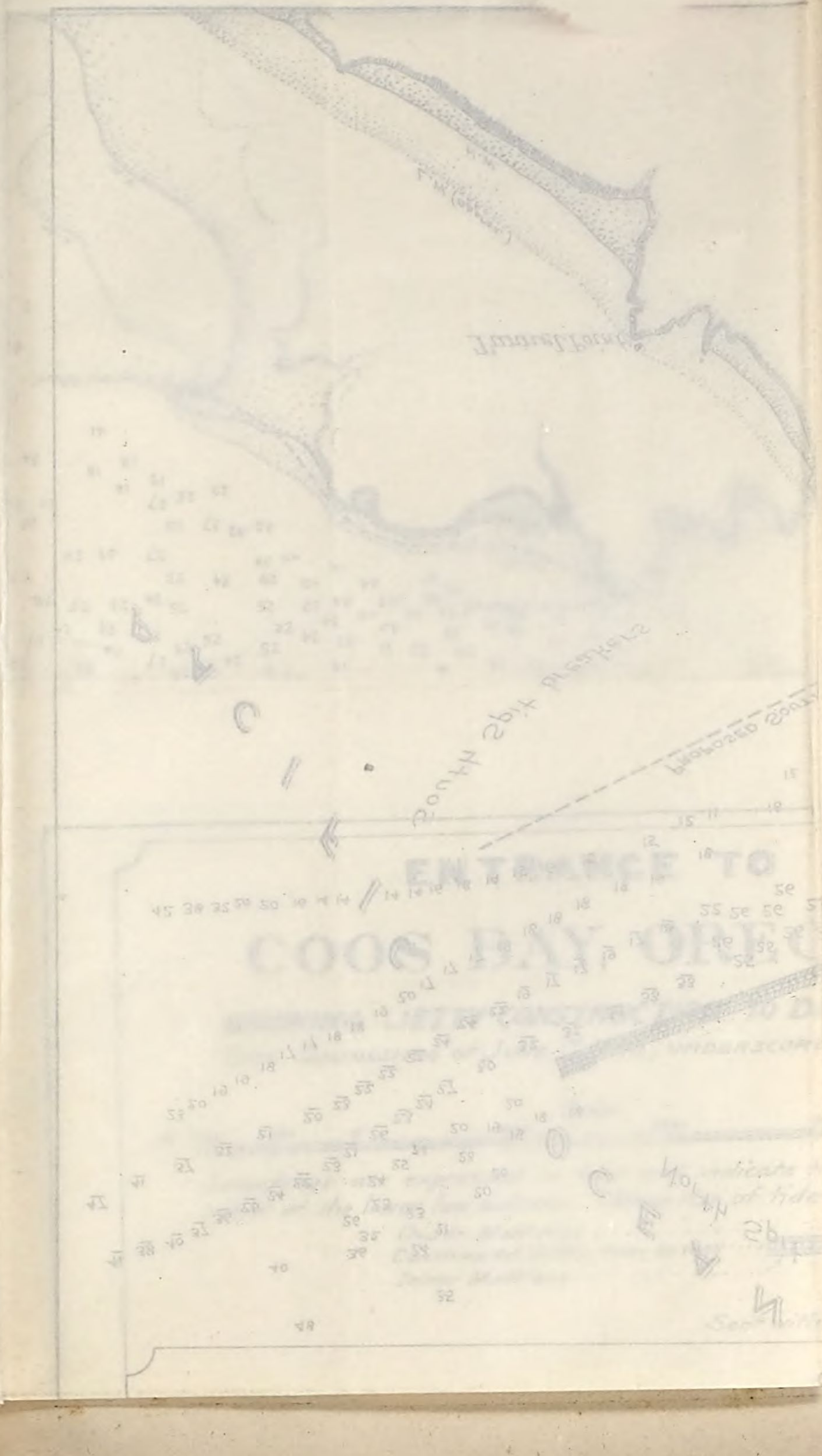
To construct two brush and stone Jetties converging upon and crossing the crest of the bar, at a distance apart of 1500 ft; the North Jetty resting upon the south end of the North Spit and the South Jetty resting upon Coos Head.

APPROPRIATIONS

			$
Act of March	3	1879	40,000.
" " March	3	1881	30,000.
" " Aug.	2	1882	30,000.
" " July	5	1884	30,000.
" " Aug.	5	1886	33,000.
" " Aug.	11	1888	50,000.
" " Sep.	19	1890	125,000
" " July	13	1892	210,000
" " Aug	17	1894	95,000

drawn by A. Downing

Eng 54 1



IMPROVEMENT OF ENTRANCE TO COOS BAY, OREGON.

PROFILE OF CONSTRUCTED JETTY

JUNE 30, 1895.

Sent with annual report for 1895.

H. W. Symond

Captain Corps of Engineers

Eng 54 1

Vessels built.—One large four-masted barkentine was built at the North Bend Shipyards and launched during October. This vessel was named *Omega*; her registered net tonnage is 555.87. She was loaded with 700,000 feet of lumber and sailed for Chili. Another vessel somewhat larger than the *Omega* is now being built at the same yards.

Exports and imports.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	EXPORTS—continued.	*Tons.*
Apples	51.7	Piles	8,540.7
Beeves (live)	31	Pickets	72
Butter	92	Potatoes	1,345.9
Blankets	2.5	Specie ($42,585.60)	.....
Broom handles	6.5	Sheep (live)	26
Boat masts	7.8	Ship knees	9.2
Coal	44,726	Ties (railroad)	200
Chittim bark	82.7	Wool	18
Cheese	99.6		
Chickens (26 dozen)	.4	Total	112,125.1
Eggs	.4		
Fish, dried	.5	IMPORTS.	
Fish (salmon, in barrels)	30.7		
Fish (salmon, canned)	143.5	General merchandise and agricultural implements	6,752
Firewood and match wood	4,326.4	Steel rails	240
Hides	6.8	Redwood shingles	40
Hogs (live)	30	Specie ($18,004.23)	.....
Laths	657.2		
Leather	45	Total	7,032
Lumber (24,911,830 feet, B. M.)	49,823.6		
Miscellaneous freight	1,749		

SUMMARY.

	Tons.	Estimated value.
Total exports	112,125	$1,009,125
Total imports	7,032	351,600

Three steamers ply between local points on the bay and four run on the Coos River route.

T T 4.

IMPROVEMENT OF HARBOR AT COOS BAY, OREGON (DREDGING).

This is a new work, the first appropriation for it having been made in the river and harbor act of August 17, 1894.

Description of original condition.—In the upper portion of Coos Bay and its tributary sloughs there are a number of shoals which interfere with navigation. The principal shoal is just below Marshfield, which is situated at the extreme upper end of the bay. The distance across this shoal at the time of the survey in 1891 was 1,600 feet and the least depth on it was 5 feet at low water.

Another shoal in Isthmus Slough, just above the coal bunkers of the Oregon Coal and Navigation Company, interfered with navigation to the Bay City mill. This shoal had a least depth of 8 feet at low water and was 1,000 feet across.

Since this survey of 1891 other shoals have formed in the upper part of the bay and the shoals mentioned in my report of May 16, 1891, have changed.

Plan of improvement.—The plan of improvement proposed was to build a dredger, with two hopper scows, and by their use to open up a channel through the two shoals.

The estimated cost of the project was $27,390.

APPROPRIATION.

Act of August 17, 1894 ..... $13,000

This appropriation is made in the act in connection with that for improving the entrance in the following language:

Improving entrance and harbor at Coos Bay, Oregon: Continuing improvement, $95,000, and for the construction or purchase of a dredger and operating the same in removing obstructions from and deepening the harbor of Coos Bay in front of Marshfield, $13,000.

As the improvement of the upper harbor is not included in the estimate for the improvement of the entrance, and as it is an entirely separate undertaking, a separate report on it is here made.

Amount expended to June 30, 1895.—The amount expended from the appropriation to June 30, 1895, was $47.10.

Report of operations.—The language of the law compels the money appropriated to be expended for the purchasing or constructing a dredger and precludes its expenditure for dredging by contract.

The money appropriated was not sufficient to build a dredger suited to the work and its location at Coos Bay, and so by direction of the Chief of Engineers it has been allowed to remain in the Treasury until enough more can be added to it to build a suitable dredging outfit and operate it.

It is to be observed and noted that the project, based upon the survey of 1891, is not applicable to existing conditions and needs modification to make it conform thereto. While the part of the project in reference to procuring the dredger is all right, a new survey should be made to determine the work necessary to be done. The original shoals have changed and others have developed, and these, combined with the deepening of the entrance to the bay, render the new survey and project desirable.

Recommendations and remarks.—Since the preparation of the original project of May, 1891, conditions have so materially changed at Coos Bay as to render the project insufficient and unsuitable.

The original project called for the construction of a small dredge boat and two hopper scows and the removal by dredging of 37,000 cubic yards from two shoals. The depth to be aimed at was 10 feet at low water. In the report of the survey the following language was used:

> With the present condition of the ocean bar, and until the work now being constructed shall have considerably improved it, all the relief necessary would be obtained by dredging a channel through the shoal at the lower end of Marshfield and the one above the coal bunkers in Isthmus Slough to a depth of 10 feet at low water and a bottom width of 100 feet.

It is now proper to state that the work done at the entrance to Coos Bay has materially changed the condition of the ocean bar, giving a bar channel in which the low-water depth is nearly double what it was in 1891. Much larger ships can now use this port than formerly, and any project for the improvement of the inside waters of the bay should be based upon the depths of the entrance, which have been procured at such great cost. The bar channel for nearly two years has had a continued depth of 18 feet and over at low water, and generally the depth has been more than 20 feet. It is obvious that the depth mentioned in the original project for dredging of 10 feet at low water is insufficient. The shoals covered by the original project have changed and new ones have formed, and it is certain that many more shoals would be developed by a survey for a channel to the extreme upper end of the bay commensurate in depth and width with the entrance channel. The project and estimate is so inadequate to existing conditions that it is

recommended that they be disregarded and a new survey, project, and estimate be made compatible with existing conditions if it shall still be deemed wise to attempt to secure and maintain a deep-water channel through the shallows of the upper part of the bay.

In view of the above I do not make any estimate of an amount which can be profitably expended for the next fiscal year on the original project.

Future operations.—It is not expected that anything will be done until additional appropriations are available.

Money statement.

Amount appropriated by act of August 17, 1894	$13,000.00
June 30, 1895, amount expended during fiscal year	47.10
July 1, 1895, balance unexpended	12,952.90
Amount (estimated) required for completion of existing project	14,390.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	

COMMERCIAL STATISTICS.

The commercial statistics of Coos Bay are given in the report on improving the entrance to the bay.

T T 5.

IMPROVEMENT OF UMPQUA RIVER, OREGON.

Description of original condition.—Just below Scottsburg, the head of navigation on the Umpqua River, are five sandstone bars or ledges 12 to 15 feet wide, and submerged from 1 foot to 2 feet at low tide on a low-river stage. They are separated by pools about 150 feet wide and from 5 to 10 feet deep at low water.

Plan of improvement.—The Honorable Secretary of War having authorized the expenditure of the balance remaining of the appropriation of March 3, 1871, viz, $4,685.89, in improving the river below Scottsburg, a project was submitted and approved in 1885 for making, at an estimated cost of $4,056, a channel 50 feet wide and 3 feet deep at low water through the rock ledges above described by drilling and blasting the rock and removing the broken pieces to deeper water in the pools.

In September, 1889, a survey was made of the Umpqua River from Scottsburg to the mouth, and a project prepared for its improvement, which was submitted January 16, 1890. This project provides for the removal of rock bowlders and ledges in the wharf basin at Scottsburg and below this basin with the view of opening a channel way 50 feet in width and 4 feet in depth at low water. The project was approved under date of October 28, 1890.

The estimated cost of completing the project was $9,000. This cost has been reestimated at $15,000.

APPROPRIATIONS.

Act of—	
March 3, 1871	$22,500
August 11, 1888	2,000
September 19, 1890	9,000
Total	33,500

Amount expended to June 30, 1894.—The amount expended on the project to June 30, 1894, was $15,475.58.

Results obtained to June 30, 1894.—There were removed during the year 1893–94 from the reef below Scottsburg 252.5 tons of rock, when, the appropriation being about exhausted, work ceased.

Amount expended during the fiscal year ending June 30, 1895.—There was expended during the fiscal year ending June 30, 1895, the sum of $122.50.

Results obtained during the fiscal year ending June 30, 1895.—No work was done during the fiscal year ending June 30, 1895, and no additional results were obtained.

Report of operations.—The last work done on the Umpqua was in 1893, and was under charge of Lieut. G. D. Fitch, Corps of Engineers.

He removed 252.5 tons of rock by blasting, hoisting on scows with the help of a diver, and depositing upon the river bank. When this was done it was found to be necessary to suspend operations for financial reasons, although the work was not completed.

Lieutenant Fitch made a survey of the rocks and reefs along the projected channel and found that there were about 500 cubic yards yet to be removed before the channel could be considered as completed.

Recommendations and remarks.—From the foregoing it is evident that the money appropriated for this work, and which corresponds in amount with the estimates, is exhausted and the work is still uncompleted.

The original estimate for the work, dated January 16, 1890, was as follows:

Removal of 1,200 cubic yards of rock, at $6 per cubic yard	$7,200
Contingencies, superintendence, etc	1,800
Total	$9,000

Up to the present time 700 cubic yards of rock have been removed at a cost of $8,788.42, or about $12.50 per cubic yard.

There are yet 500 cubic yards to be removed to provide a channel 50 feet wide and 4 feet deep at low water.

It is estimated that it will cost $12 per cubic yard to remove these 500 yards, or $6,000.

I am compelled, therefore, to make this supplementary additional estimate of $6,000 to complete the project adopted for the improvement of the Umpqua River.

The discrepancy between the actual cost of doing the work and the estimated cost, necessitating this supplemental estimate, can only be explained by stating that, in making the original estimate, the difficulties in the way of doing the work were not fully appreciated. The work is situated in a remote region difficult of access, to which it was expensive to supply men, materials, and tools, and devoid of facilities to aid in the operations. There were about 4 feet of tide to contend with, and all the rock removed had to be handled by a diver.

The work has to be done when the water is clear, and any storm in the watershed of the river interfered with operations by muddying the water. The work was well under way at one time when the river rose suddenly and became permanently muddy for the season, compelling a cessation of operations. This caused the dispersal of the entire outfit, the storage of tools and supplies, and the renewal of all operations another year.

The cost of collecting men, tools, and supplies, and dispersing and disposing of them on two occasions was an important function in the discrepancy between the estimated and actual cost.

The work on the Umpqua is left in such a condition that that which is done can be of little benefit until the whole channel is completely excavated. I would therefore recommend that $6,000 be appropriated to complete the work on the Umpqua River.

Money statement.

July 1, 1894, balance unexpended	$210.31
June 30, 1895, amount expended during fiscal year	122.50
July 1, 1895, balance unexpended	87.81
Amount (estimated) required for completion of existing project	6,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	6,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

Umpqua River is in the collection district of southern Oregon. Empire City, Coos Bay, is the nearest port of entry. The nearest light-house is situated about one-half mile south of the entrance to the Umpqua River.

The following returns relative to the commerce of the Umpqua River, for the fiscal year ending June 30, 1895, are furnished by Mr. O. B. Hinsdale, of the Gardiner Mill Company, Umpqua River:

Vessels arrived and cleared.

The number of coastwise vessels arriving in the Umpqua River during the year was 90; the number of clearances was 90; of this number 50 were steam vessels and 40 were sail vessels. The maximum draft of loaded vessels was 14½ feet.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.			IMPORTS.		
	Tons.			*Tons.*	
Lumber (10,800,000 feet, B. M.)	21,600	$108,000	General merchandise	1,500	$75,000
Laths (43,000 bundles)	1,075	10,750	Agricultural implements	100	5,000
Salmon, in cases	210	24,000	Cannery supplies	125	5,000
Butter and cheese	10	3,000	Total	1,725	85,000
Potatoes (600 sacks)	30	480			
Grain	204.2	5,000			
Fruit	10	200			
Salted meats (100 barrels)	10	500			
Chittim bark	5	300			
Wool	10	1,500			
Hides and furs	2	600			
Total	23,166.2	149,230			

SUMMARY.

	Tons.	Estimated value.
Total exports	23,166	$149,230
Total imports	1,725	85,000

Umpqua River traffic.

Steamer *Juno* (propeller), of 22.28 tons capacity, runs between Gardiner and Sulphur Springs. Passengers carried during year, 1,550; freight carried during year, 500 tons.

Steamer *Restless* has been dismantled and replaced by steamer *Eva*, a stern-wheel boat built at Portland, Oreg. This boat runs from Gardiner to Scottsburg. Passengers carried during the year, 2,050; freight carried during the year, 1,000 tons.

No vessels have been built since date of last report. The only boat running on the portion of the river under improvement is the steamer *Eva*, above mentioned.

T T 6.

IMPROVEMENT OF MOUTH OF SIUSLAW RIVER, OREGON.

Description of original condition.—The Siuslaw River enters the ocean in the midst of a vast shifting, sandy beach without any headland or fixed point to determine the location of the entrance channel.

The unconfined channel has a range of about 1 mile, over which it wanders in making connection with the ocean. In consequence of this wandering and spreading out of the outgoing and incoming waters the bar at times shoals very badly, while at other times it has a depth equal to the controlling depth inside the entrance. The depth in the bar channel varies from 5 to 12 feet at low water and the channel changes very much in position and direction.

At times a channel is developed inside the bar, which runs nearly parallel with the coast. This channel is narrow, badly defined, and dangerous, as boats have to pass through it in the trough of the sea. At other times there are two channels.

Plan of improvement.—The plan of improvement for the entrance to the Siuslaw is to confine the outgoing and incoming waters between high-tide stone jetties so located as to direct the currents upon the ocean bar in a direction practically perpendicular to the coast, these jetties to converge till they are 600 feet apart at the crest of the bar.

The location of the jetties is approximately shown upon the map published with the annual report from this office for 1891 (Report of Chief of Engineers, 1891, p. 3178) and for 1893 (Report of Chief of Engineers, 1893, p. 3346).

The north jetty leaves the mainland about half a mile north of Cannery Hill and is to be 4,500 feet long.

The south jetty is to extend from the end of the sandy peninsula and is to be 3,200 feet long.

The jetties are to be built of brush and stone from a pile tramway. The estimated cost of the work was $700,000.

APPROPRIATIONS.

Act of—	
September 19, 1890	$50,000
July 13, 1892	20,000
August 17, 1894	25,000
Total	95,000

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $68,651.08.

Results obtained to June 30, 1894.—The work has been mostly of a preliminary character and consists of the construction and assembly of the necessary plant, the construction of the wharf to connect with the north jetty, of requisite buildings, and the construction of a railway trestle along the beach to connect with the root of the north jetty. The jetty proper was but fairly started beyond the low-water line. The appropriation having been nearly exhausted at the close of the fiscal year ending June 30, 1893, the work was suspended and the plant and premises placed in charge of a watchman. During the year ending June 30, 1894, the tramway and wharf were partially destroyed by wind, waves, and landslides. The work has not progressed far enough to produce any results upon the bar.

Amount expended during the fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $2,609.52.

Results obtained during the fiscal year ending June 30, 1895.—But little work upon the project was done during the year. It having been decided to continue the work by contract, it was advertised February 11, 1895, and bids were opened March 16, 1895.

The following is an abstract of bids received:

No.	Name and address of bidder.	Piles, per linear foot.	Lumber, per M feet, B. M.	Bolts, with nuts and washers.	Driftbolts, complete.	Brush mattresses, per cubic yard.	Stone, per ton.	Total.
		Cents.		*Cents.*	*Cents.*		*Cents.*	
1	Dickinson & Co., Tacoma, Wash	10	$12.00	*20	3	$0.75	95	$15,450.00
2	Wm. Jacobsen and J. M. Nickum, Portland, Oreg	9¾	12.25	†5	15	.65	73½	12,818.13
3	Chas. P. Church, Portland, Oreg	10	14.00	*25	20	1.20	75	14,100.00
4	Jos. Paquet and Benj. F. Smith, Portland, Oreg	16¼	14.50	*20	21	.96	99	17,721.88
5	Perry Hinkle, Portland, Oreg	8	9.00	†3	10	.50	70	11,499.00
6	Rich. Hoyt, Portland, Oreg	8	11.00	†5	†5	1.00	65	11,915.00
7	Daniel Kern, Portland, Oreg	7	9.00	†5	15	.25	72	11,252.50
8	Wm. Kyle and Oscar W. Hurd, Florence, Oreg	14½	9.95	†17	17	1.65	64½	13,859.75
9	Chas. W. Tower, Marshfield, Oreg	14½	19.00	*20	15	.70	89	16,228.75

* Each. † Per pound.

The contract was awarded to the lowest bidder, Daniel Kern. The work is to consist of the repair and extension of the jetty tramway, the placing of brush mattresses if required, and the furnishing and placing of stone in the jetty enrockment.

At the close of the year the contractor had but fairly commenced operations under his contract and no material benefits had resulted.

Recommendations and remarks.—For a long period this spring the entrance to the Siuslaw has been very bad, several lumber schooners having been bar bound in the river for weeks. The channel is in its most northerly position.

It is to be hoped that with the extension of the jetty, which can be made with the available funds, the channel will be determined in its southern position and be much improved.

It is estimated that the sum of $50,000 can be profitably expended upon the project during the fiscal year ending June 30, 1897.

Future operations.—Work will continue on the jetty as far as practicable with available funds.

Money statement.

July 1, 1894, balance unexpended		$1,348.92
Amount appropriated by act of August 17, 1894		25,000.00
		26,348.92
June 30, 1895, amount expended during fiscal year		2,609.52
July 1, 1895, balance unexpended		23,739.40
July 1, 1895, outstanding liabilities	$350.00	
July 1, 1895, amount covered by uncompleted contracts	11,252.50	
		11,602.50
July 1, 1895, balance available		12,136.90
Amount (estimated) required for completion of existing project		605,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		50,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

COMMERCIAL STATISTICS.

The Siuslaw River is in the collection district of Yaquina. The nearest port of entry is Yaquina City, on Yaquina Bay. The nearest light-house is at Hecata Head, 8½ miles to the north of the entrance to the Siuslaw River.

The following returns for the fiscal year ending June 30, 1895, are furnished by Mr. James Fairweather. of Florence, Lane County, Oreg.:

Arrivals and departures of vessels.

Coastwise, steam, and sail vessels.	Number.	Aggregate tonnage.
Arrivals	68	4,056
Departures	66	3,800
Total	134	7,856

Of this number 41 were steam vessels and 27 were sail vessels. Maximum draft of loaded vessels, 9 feet.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.			IMPORTS.		
	Tons.			*Tons.*	
Lumber (5,870,000 feet, B.M.)	11,740	$58,700	General merchandise	1,640	$65,600
Salmon in barrels	30	1,650	Cannery supplies	320	9,600
Salmon in cases	648	72,000	Flour and feed	125	3,750
Wool	4.5	720	Miscellaneous	60	3,000
Hides and furs	3	345			
Chittim bark	65	3,900	Total	2,145	81,950
Potatoes	47	940			
Butter	7.5	2,700			
Cord wood (225 cords)	576	787			
Miscellaneous	30	600			
Total	13,151	142,342			

SUMMARY.

	Tons.	Value.
Total exports	13,151	$142,342
Total imports	2,145	81,950

River traffic.

The following steamboats make daily trips from Florence to Acme, Point Terrace, and Seaton, 20 miles and return. During winter months biweekly trips are made only.

Steamer *Coos*, draft 3 feet, tonnage 53.5; steamer *Mink*, draft 2 feet, tonnage 5; steamer *Lillian*, draft 6 feet, tonnage 25.5.

There have been no changes in routes and service of these boats since date of last report.

No vessels were built during the year.

T T 7.

IMPROVEMENT OF YAQUINA BAY, OREGON.

Description of original condition.—The usual prevailing depths over the bar at low water before improvement were from 7 to 8 feet. Three distinct channels existed, known as the North, Middle, and South channels. The South Channel was the one mostly used, but was rendered dangerous by the presence of rocks. The Middle Channel, though free from rocks, was usually the shoalest of the three, and so was little used. The North Channel, besides being long and tortuous, was so studded with rocks as to be considered unnavigable. Owing to the shifting nature of the bar these channels were constantly changing both in position and depth.

The mean rise of tide was 7.1 feet.

Plan of improvement.—The project, adopted in 1881, was to run out a dike or jetty on the south side of the entrance, so as to cause the South Channel to shoal up and the flow to be deflected northward, with a view to opening and maintaining the Central Channel with a least depth of 17 feet at high water.

As orginally projected the dike was to start from near low-water line and run out into the sea a distance of 2,500 feet and was to rise to 2 feet above mean low water. The beach on the line of the jetty from high-water level was to be protected by sinking gabions in the beach with sand heaped over them and by covering the surface with a layer of mattresses and stone.

The stone for the jetty was to be deposited in place from barges, and cribs were to be used if practicable. It was found, however, that cribs could not be used on account of the strong currents and high seas, and that the ocean swell, even in quiet weather, was too great to permit the use of stone barges. Accordingly the jetty had to be built from the shore end by carrying the stone out over a tramway, and was begun at high-tide line, thus making the total projected length of the jetty, in 1881, 3,700 feet. In 1884 the jetty was extended shoreward a distance of 316 feet to close a gap that had been washed out by the sea, making the total projected length at that time about 4,000 feet.

The present project, adopted in 1888, is to raise the south jetty to full high water without extending it seaward, thus making its total length 3,748 feet, and to construct a midtide jetty on the north side of the entrance about 2,300 feet in length, extending from the north head along and behind the reef, putting out from the head to a point opposite the end of the south jetty and distant from it about 1,000 feet.

The project of 1888 was modified in 1892 by the requirement that the north jetty be raised to full high tide and that five groins be built from the south jetty channelward in order to prevent the currents undermining the jetty.

It was estimated on January 13, 1890, that it would require $370,000 to complete this existing project. Since then $300,000 has been appropriated, leaving a balance of $70,000 on the estimate.

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1880	$40,000	September 19, 1890	$165,000
March 3, 1881	10,000	July 13, 1892	85,000
August 2, 1882	60,000	August 17, 1894	50,000
July 5, 1884	50,000		
August 5, 1886	75,000	Total	685,000
August 11, 1888	150,000		

Amount expended to June 30, 1894.—The amount expended on the project to June 30, 1894, was $626,093.34.

Results obtained to June 30, 1894.—The north jetty had been built to its full length, but was not finally completed. The south jetty tramway had been repaired and the groins authorized had been partially completed. A good bar depth and location of channel were kept uninterruptedly during the year.

Amount expended during the fiscal year ending June 30, 1895.—The amount expended on the project during the fiscal year ending June 30, 1895, was $37,054.40.

Results obtained during the fiscal year ending June 30, 1895.—The results were practically the same as for the preceding year. A good bar depth and location of channel were kept uninterruptedly during the year. The ordinary bar channel depth, as reported, was from 12 to 15 feet at mean lower low water.

The inner bar, which gradually disappeared during the summer and autumn of 1893, reestablished itself in its former location and proportions during the winter and spring (1893–94). This has not as yet been any actual detriment to commerce, although there were grave apprehensions that it might become so. To remedy the evil two of the groins from the south jetty were extended, one 300 feet and one 100 feet, and it is believed that this inner bar will give no further trouble.

Report of operations.—At the beginning of the fiscal year 1894–95 the work at Yaquina Bay was in a state of suspension, awaiting further appropriations. Several surveys of the harbor in the vicinity of the inner bar were made, and the plant was repaired and put in order for further work.

As soon as the appropriation bill became a law active operations commenced. Derricks were erected, fender piles driven at the wharves and at the quarry, the mess house was organized, and the work of removing débris begun.

The placing of stone in the north jetty commenced in September, during which 2,706 tons were placed in the north jetty. While this was going on on the north side the tramway of the south jetty was being repaired.

During November a project was submitted for the extension of two of the south jetty groins, with the expectation that they would then be instrumental in keeping down the bothersome inner bar. The extension of groin No. 2 (300 feet) and groin No. 4 (100 feet) was approved, and they were so extended. The work of enrocking them is in progress.

In November a contract was entered into with the Pioneer Sandstone Company to deliver 10,000 or more tons of rock on the wharf at Yaquina City at the rate of 300 tons per day.

The company delivered in all 12,627.84 tons, but signally failed to deliver the amount called for per day. This resulted in severe loss to the Government, as it costs about as much to unload and handle 100 tons per day (about the average amount delivered) as it does 300 tons per day.

After in vain endeavoring to get the company to deliver stone faster, their contract was annulled on March 16, 1895, and all work ceased while the work of furnishing stone was advertised.

On April 11, 1895, the bids were opened and the following were received:

No.	Name and address of bidder.	Stone from Government quarry, per ton.	Stone from quarry at Big Elk River, per ton.	Stone from Morrison quarry, on Oregon Pacific Railroad, per ton.	Stone from Toner quarry, on Oregon Pacific Railroad, per ton.	Stone from Pioneer quarry, on Oregon Pacific Railroad, per ton.	Total.	
							From Government quarry.	From other quarries.
1	Daniel Kern, Portland, Oreg	$1.30	$0.85				$13,000.00	$8,500.00
2	Erixon & Luker, Salem, Oreg			$0.77				7,700.00
3	Rochester & Simpson, Elk City, Oreg	.68			$1.25		6,800.00	12,500.00
4	George T. Hitchcock, Portland Oreg	.65	.75				6,500.00	7,500.00
5	George W. Davis, Salem, Oreg					$1.15		11.500.00

The contract was awarded to Daniel Kern, who commenced the delivery of stone about June 1. Work under his contract is still in progress.

A Board of Engineers was appointed to consider the subject of the further improvement of Yaquina Bay, and at the request of the Board a survey was commenced, having for its object the obtaining of a full knowledge of the existing conditions and particularly of the currents through and about the entrance and on the inside and outside of the outlying barrier reef. This survey is in progress at the close of the fiscal year. The steamer *Gen. H. G. Wright* was repaired at Coos Bay and was used for the work.

Recommendations and remarks.—It was hoped that the last appropriation would enable the work at Yaquina Bay under the existing project to be fully completed, but circumstances have rendered the hope vain, and it is necessary to ask for another appropriation to fully complete the work. The principal items which have caused the amount to fall short of completing the project are the expenses of repairing the steamer *Gen. H. G. Wright* and making the surveys required by the Board of Engineers on the further improvement of Yaquina Bay, the expenses of the Board, preparation of maps, etc., the failure of the Pioneer Sandstone Company to supply stone rapidly enough as specified in their contract, the additional amount of stone required to make up for settlement and beating down of the jetties, and particularly the great amount of stone required for the 400-foot groin ordered in November, 1894. This groin extends out into the deep channel, and along it the tidal currents run with great velocity. The extension of 300 feet was apparently undermined as fast as built until the limit of scour was reached, and the amount of stone used was vastly greater than anticipated.

It is intended that with the present appropriation the south jetty and groins shall be fully completed, the end of the north jetty tramway restored, and the enrockment be brought up to its full height. It is estimated that to put the north jetty into a condition in which it can be left with full confidence in its permanence will require about 15,000 tons of stone more than can be put in with the existing appropriation. Estimating this at $1.50 per ton and $2,500 for repairs to tramway, office expenses, engineering, and superintendence, makes an amount of $25,000, which is required to fully complete the improvement specified in the project.

As far as effect goes the work is practically completed, the additional amount of rock required being in the nature of insurance against break, which might occur hereafter.

The practical completion of this work in accordance with the existing project seems a proper occasion to state that it has been eminently successful, and has fully carried out the hopes and wishes of its projectors. From an uncertain bar channel of 6 and 7 feet depth, shifting over a great range, a bar channel has been developed by the works constructed of 12 to 15 feet depth at the mean of the lower low waters, and with a permanent location.

A Board of Engineers appointed under authority of law (sundry civil act approved March 2, 1895), and consisting of Lieut. Col. Amos Stickney, Maj. James C. Post, and Maj. C. B. Sears, met at Yaquina Bay on May 11, 1895, under instructions to consider the matter of the further improvement of the bay. In accordance with the desire of the Board a survey is being made to determine existing conditions and to obtain a full knowledge of prevailing currents. This survey has not yet been completed, and the Board has not yet made its report.

Future operations.—Future operations will consist in the completion of the survey, and of the enrockment of the south jetty and its groins, and of enrocking the end of the north jetty.

Money statement.

July 1, 1894, balance unexpended		$8,906.66
Amount appropriated by act of August 17, 1894		50,000.00
		58,906.66
June 30, 1895, amount expended during fiscal year		37,054.40
July 1, 1895, balance unexpended		21,852.26
July 1, 1895, outstanding liabilities	$1,000.00	
July 1, 1895, amount covered by uncompleted contracts	8,500.00	
		9,500.00
July 1, 1895, balance available		12,352.26
Amount (estimated) required for completion of existing project		25,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		25,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

REPORT OF MR. J. G. HOLCOMBE, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Newport, Lincoln County, Oreg., June 10, 1895.

SIR: I have the honor to submit the following report on the improvement of Yaquina Bay, Oregon, for the year ending June 30, 1895, during which time I have been in local charge of all operations:

Inspections.—The following official inspections were made during the year: By Colonel Mendell on October 19, 1894; by Captain Symons on August 4 and 5, and October 19, 1894, and April 15, and May 11, 1895; by Lieutenant Shunk on September 28, 1894; by the Board of Engineers appointed to consider the further improvement of Yaquina Bay, on May 11, 1895, and by Senator Dolph on September 20, 1894, and by Senator McBride on May 11, 1895.

North jetty.—At the end of the fiscal year, June 30, 1894, the enrockment all along this jetty had been brought up above high tide, but it was deemed necessary, on the resumption of work September 13, 1894, to place more rock at various points, especially at the end, to strengthen and allow a good margin for settlement. Work continued until October 15, during which period 2,820 car loads or 5,399 tons were placed on the jetty, mostly at the outer end, making a high mound, which at places was above the level of the tramway.

The cost of this work was as follows:

Labor	$1,662.40
Supplies and fuel	341.51
Quarrying the stone	2,877.10
Towing from quarry	616.66
Total	5,497.67

or $1.018 per ton in place. This does not include the cost of depreciation of the plant, but does include the office expenses at Newport.

In building the mound at the outer end of the north jetty the largest stone available was used, but the storms of winter have completely demolished it and cut it down to about low-water level.

These storms have forced the high-water level north of the jetty considerably farther than it had been for a long time, and broken through the jetty at one or two places. This beating-down process has also carried away the piling in places, which will have to be replaced before the enrockment can again be built.

South jetty.—At the end of the fiscal year, June 30, 1894, this south jetty had been built to its full length, and five groins, extending out into the channel for a distance of 60 to 100 feet, had also been built; the enrockment had been brought up above high tide for the entire length of the jetty and groins. A large mound had been made at the end, but it was deemed necessary to add more stone for the purpose of strengthening it and to allow a margin for settlement, the stone being soft sandstone. Work was resumed on the jetty October 15, 1894, and continued until November 6. During this period 1,905 cars or 4,916 tons of stone from the Government quarry were placed on the jetty and groins.

On the 15th of November, under contract with the Pioneer Sandstone Company, the first stone was received from their quarry and placed on the jetty. During the continuance of their contract, which terminated March 16, 1895, 12,627.84 tons of stone were received, all of which was deposited on the jetty.

A new contract was entered into on April 30, 1895, with Mr. Daniel Kern for stone from the Dixon quarry. Mr. Kern commenced the delivery of stone on June 1.

The cost of placing the stone on the jetty from the Government quarry was as follows:

Labor	$947.49
Supplies and fuel	91.94
Quarrying of stone	2,610.47
Towing from quarry	250.00
Total	3,899.90

or $0.793 per ton. As in the cost of stone for the north jetty, this does not include the first cost or depreciation of the plant, but does include office expenses at Newport.

Under the contract with the Pioneer Sandstone Company, the cost was as follows:

Stone	$6,205.09
Labor (unloading from cars to scows)	1,754.48
Labor (unloading and dumping on jetty)	3,335.98
Supplies and fuel	569.11
Towing from Yaquina	1,763.33
Total	13,627.99

or $1.079 per ton of stone. This extreme cost was due to the very unsatisfactory manner in which this contract was carried out by the Pioneer Sandstone Company, they at no time delivering the amount called for by their contract. Their rate of delivery averaged only about 119 tons per day, while their contract called for 300 tons per day. The towing and a large part of the expense at the quarry was of such a nature that it could not be reduced to meet the fluctuations in the delivery of rock. All the stone received from the company was of large size and excellent quality.

Under date of November 28, 1894, I received orders to extend groins Nos. 2 and 4 300 and 100 feet respectively. These groins were extended for the purpose of preventing the formation of an inner bar between the jetties. The pile driving for these extensions was started on December 10, 1894, and completed on February 25, 1895. The enrockment is now in progress.

The cost was as follows:

Labor	$1,000.84
Supplies and fuel	87.71
Piles, lumber, etc	729.71
Total	1,818.26

The cost of this work was governed by having to drive the piles at right angles to the current, and because of the unsafe condition of the old tramway; the movements of the large and heavy pile driver were very slow, it being necessary to level up and otherwise strengthen the tramway before taking the driver over it.

As stated above, this tramway is old and needs constant attention and repairs to make it safe to handle trains over it. If future work is carried on at this place, the tramway from the shops to its end will have to be rebuilt, and heavy repairs made from the shops to and including the receiving wharf.

Quarry.—On June 30, 1894, the quarry and plant were in charge of a watchman. On August 20, 1894, when operations were resumed under the new appropriation, the work of stripping and removal of the large accumulation of débris that had been brought down by the storms since the cessation of work began. In order to get the quarry into as good order as possible before the rainy season set in, a large force was employed and the work pushed vigorously until September 12, when the first scow was loaded with stone. During the period of operations at the quarry, August 20 to October 30, 1894, 24,496 tons of débris were removed and 43 scow loads or 10,415 tons of stone sent to the jetties.

The rock at this quarry is poor and soft and covered with a large quantity of débris. For this reason it was thought best to suspend operations and contract for a stone supply; this contract was awarded to the Pioneer Sandstone Company, who under it furnished on board the Oregon Pacific Railroad cars, at Yaquina Dock, 12,627.84 tons of stone.

The mess house at the quarry was run by the Government, and furnished 1,777 rations, at an average cost of 41 cents per ration.

The cost during the year for this part of the work was as follows:

Labor	$4,534.46
Fuel, stores, and material	267.76
Total	4,802.22

This is the cost of 10,415 tons of stone, or about 46 cents per ton, loaded on scows at the quarry. This cost also includes the office and incidental expenses incurred at Newport.

Dock at Yaquina City.—The contract with the Pioneer Sandstone Company rendered it necessary to erect a derrick and engine on the dock at Yaquina City; also a small extension to the existing dock there, to unload stone from the cars to the scows. This work was commenced October 26 and finished November 9, 1894. The first stone was unloaded November 13.

The cost of the dock and derrick was as follows:

Labor	$428.53
Lumber, piling, and stores	229.27
Total	657.80

The cost of unloading stone was as follows:

Labor	$1,553.56
Fuel, stores, etc	200.92
Total	1,754.48

Towing.—The towing during the year has been done by the tugboat *Volanta*. From September 12 to November 4, 1894, she towed 43 scows from the Government quarry to the jetties, at a monthly rate of $500, and from November 12, 1894, to March 20, 1895, from Yaquina City to the jetties, 59 scows, at a monthly rate of $400. The cost of this work was $2,629.99.

Surveys and examinations.—During the year two examinations were made of the channel between the end of the jetties and Newport, and the maps thereof forwarded to you. A complete survey is now in progress of the bar and channel from Newport. The field notes are not yet completed.

The bar.—The bar has maintained itself in excellent shape, and no vessel, loaded or empty, has been bar bound during the year. During the winter months the bar was reported by several steamers, including the light-house tender, as having 17 feet at low water. The Light-House Board has established range lights for the purpose of lighting the channel over the bar and the channel in the bay. It is now a common occurrence for vessels to come and go at all hours of the night.

Commercial statistics.—I append to this report the usual commercial statistics of this port. They show a marked improvement over last year. A great deal is due to the development of the local industries tributary to the bay and the fact that the

railroad (Oregon Central and Eastern) has gone into a new management that is using every energy to build up and benefit the country.

Among the local industries is the opening of the Pioneer sandstone quarry and the heavy shipments of fine building stone that they have made to San Francisco.

The first creamery was established on the bay this spring, and it is the forerunner of others that will be built in the future.

A diamond drill is now employed in prospecting the coal field, as outlined in my last annual report.

Miscellaneous.—The sand fence built the previous year at the north jetty has been nearly all carried away, but little of it remaining.

The miscellaneous work on this side has consisted in minor repairs to the plant, retubing the hoisting engine being the most important.

On the south side the boiler of the floating pile driver was retubed, a gridiron for repairing scows was built, and new piles were placed under the receiving wharf.

The scows belonging to this work are eight in number, as follows: Nos. 7, 8, 9, 10, 11, 12, 13, and 14. It will be necessary to have these scows hauled out and recalked and new upper timbers and decks put on them if they are to be used on this or other works in the future. Six old scows have been condemned and sold.

The project.—The project of 1888 as approved is nearly completed. All that remains to be done is to place more stone on both jetties and groins for the purpose of making them permanent structures. This is now being done. It is probable, from the more exposed position of the north jetty to the full force of the waves and their tendency to beat it down, that still further enrockment will be required.

Before closing this report I wish to express my thanks to Mr. Arthur S. Eldridge, clerk and timekeeper; George Williams, foreman at the jetties, and Arthur Rochester, foreman at the Government quarry and Yaquina Dock, for the efficient and faithful services rendered by them in carrying out the details connected with the work.

Very respectfully,

J. G. HOLCOMBE,
Assistant Engineer.

Capt. THOMAS W. SYMONS,
Corps of Engineers.

COMMERCIAL STATISTICS.

Yaquina Bay is in the collection district of Yaquina. Yaquina City is the port of entry. The nearest light-house is at Yaquina Head, 4½ miles north of the entrance.

The following returns for the fiscal year ending June 30, 1895, are furnished by Mr. J. G. Holcombe, assistant engineer, in local charge of work at Yaquina Bay:

Arrivals and departures of vessels.

Name and rig.	Net tonnage.	Draft.	Arrivals.	Departures.
		Feet.		
Steamship Homer	331.04	17	27	27
Steamship Farallon	565.55	18.5	6	6
Steamship Manzinita*	450	11.5	6	6
Steamship Columbine*	424.13	12.8	2	2
Steam schooner Scotia	132.73	9.5	9	9
Steam schooner Bandorille	96.33	8.5	15	15
Steam schooner South Coast	209.35	10.5	6	6
Steam schooner Augusta	40.90	7.1	3	3
Steam schooner Alcatraz	193.98	10.8	5	5
Steam schooner Excelsior	364.60	13.5	1	1
Steam schooner Lakme	404.18	12.6	1	1
Steam schooner Tonquin	18.61	.....	1	.....
Steamship Arcata	415.56	8.6	3	3
Steam schooner General Wright	44.52	7.5	1	.....
Tug Roberts	24.18	6.5	33	33
Total	.....	.....	119	117

*Light-house tender.

Total aggregate tonnage of arrivals and departures, 47,100 36.

Steamboats on the bay and river.

Name.	Tonnage.	Draft.	Service.
		Feet.	
Volanta	44.24	3.6	Passenger boat, Newport to Yaquina and towing Government scows.
Resolute	44.92	10.8	Licensed but not in service.
Walluski	68.86	6	Do.
T. M. Richardson	24.53	5	Not licensed.

Exports and Imports.

Articles.	Quantity.	Articles.	Quantity.
EXPORTS.	*Tons.*	EXPORTS—continued.	*Tons.*
Wheat	2,806.4	Excelsior	12
Oats	2,434.6	Stave bolts	163
Flour	2,803	Miscellaneous	854.8
Potatoes	1,612.6		
Building stone	6,377.9	Total	25,915.2
Cord wood	542.6		
Bark	185	IMPORTS.	
Bran and feed	753.5		
Hides and leather	79	General merchandise and groceries	3,411.3
Buggies	6.1	Iron (pig, sheet, bar, and pipe)	534.7
Chairs	1.2	Tin plate	30.5
Lumber (35,450 feet, B. M.)	70.4	Hardware, nails, etc	543.8
Salmon (canned)	145.9	Household goods	16
Hops	13	Grain sacks	131.5
Hardware	10	Coal	271.6
Fir balsam	20	Malt	166.5
Wool	16.5	Fruit	154
Seed	1.2	Salt	697.8
Apples	5		
Poultry	1.5	Total	5,957.7

SUMMARY.

	Tons.	Estimated value.
Total exports	25,915.2	$414,802
Total imports	5,957.7	297,850

Passengers arrived by sea during year 395
Passengers departing by sea during year 456

No vessels have been built on bay since last report.

T T 8.

IMPROVEMENT OF TILLAMOOK BAY AND BAR, OREGON.

Description of original condition.—Tillamook Bay is an indentation of the Oregon coast about 50 miles to the south of the Columbia River. It has a tidal area of about 13.5 square miles, with a mean rise and fall of the tide of 6.5 feet. The usual bar exists at the entrance to the bay.

The channel over the bar is direct and shifts in position but little in comparison with the change in many of the Pacific Coast bars. Changes in position and depth are, however, effected with great rapidity.

The bay at low tide consists of three channels running through sand and mud flats. These channels are of fair depth near the entrance, but gradually shoal up, giving depths of only 1 or 2 feet near the head of the bay. Tillamook City, the principal town of the region, is situated on a tidal slough above the head of the bay, and can only be reached by light-draft vessels at high tide. To reach Tillamook City it is necessary to use the Middle Channel of the bay. The only other places of any importance on the bay are situated along its north shore, and access to them is by the North Channel. There is no navigable connection between the North and Middle channels except very near the entrance to the bay. In consequence of this, vessels entering the bay and going to points along the north shore in order to reach Tillamook City are compelled to retrace their course nearly to the entrance and then go up the Middle Channel.

Plan of improvement.—The plan of improvement covered by the existing and approved project is to make a navigable pass from the North to the Middle Channel so that boats can go to points along the north shore of the bay and then keep right on up to the head of the bay, and up Hoquarton Slough to Tillamook City. This involves the improvement of Junction Bar, near the head of the bay, by building a dike of piles, brush, and stone to deflect the waters from the South Channel into the Middle Channel, and the improvement of Dry Stocking Bar in Hoquarton Slough by closing one of the two channels which exist there.

The estimated cost of the work approved was $100,000.

Besides the work covered by the existing project, other work has been done with the former appropriations, aggregating $5,700.

APPROPRIATIONS.

Old project:	
Act of—	
August 11, 1888	$5,200
September 19, 1890	500
New project:	
Act of—	
July 13, 1892	15,000
August 17, 1894	16,000
Total	36,700

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $16,696.90. Of this, however, $5,700 was expended under the old project, and $10,996.90 under the new project.

Results obtained to June 30, 1894.—The results accomplished to June 30, 1894, were the complete construction of the Dry Stocking Bar Dike, 900 feet in length, and the construction of 1,200 feet of the Junction Bar Dike from Dicks Point northward.

Amount expended during the fiscal year ending June 30, 1895.—The amount of money expended during the fiscal year ending June 30, 1895, was $2,593.99.

Results obtained during the fiscal year ending June 30, 1895.—The work already done has resulted in materially deepening the water on Junction Bar. The water on Dry Stocking Bar has not deepened to any great extent owing to the deflection of the waters of the Trask from Hoquarton Slough by jams.

Report of operations.—Bids for doing the work of improving Tillamook Bay were opened February 18, 1895.

The following is the abstract of the bids received:

No.	Name and address of bidder.	Piles, per linear foot.	Lumber, per M feet, B. M.	Bolts, each.	Spikes, per pound.	Brush, per cord.	Wire, per pound.	Stone, per ton.	Total.
1	American Bridge and Contract Co., Portland, Oreg	*Cts.* 6	$10.10	*Cts.* 20	*Cts.* 5	$1.85	*Cts.* 6	*Cts.* 60	$15,623.75
2	Charles Ewing, Portland, Oreg	6	8.50	12	2½	1.90	2½	46	13,385.75
3	Dickinson & Co., Tacoma, Wash	8½	12.50	18	3½	2.30	3½	58	17,146.25
4	Daniel Kern, Portland, Oreg	9	12.00	20	5	2.25	4	60	17,535.00
5	Pacific Paving Co., Portland, Oreg	8	12.00	30	4	2.25	5	58	17,111.00
6	William Jakobsen, Portland, Oreg	7½	11.00	16	3	1.75	2½	45	13,640.00
7	R. Hoyt and R. Smith, Portland, Oreg	7¾	11.00	22	4	2.25	3½	55	16,369.75
8	Chas. King, Tacoma, Wash	8	11.00	18	3	2.98	3	55	18,054.50
9	King & Marrinan, Seattle, Wash	8	13.00	28½	4	2.25	4	54	16,611.75
10	Mears & Brown, Tillamook, Oreg	8	9.00	11	2	2.50	1¾	58½	16,932.50
11	Perry Hinkle, Portland, Oreg	8	12.00	22	4	2.30	4	58	17,063.00
12	G. O. Nolan, Tillamook, Oreg	25	20.00	10	3	5.00	10	90	33,660.00

The contract was awarded to Charles Ewing, the lowest bidder.

Mr. Ewing went to Tillamook the latter part of March, and spent most of the month of April getting ready for active prosecution of the work, procuring materials, opening a quarry, etc.

Pile driving began on May 1, and active work continued to the close of the fiscal year.

Recommendations and remarks.—Mr. David B. Ogden, assistant engineer, who has had local charge of the work for the Government, spent the period of waiting in making valuable surveys of the network of sloughs and rivers entering the head of Tillamook Bay.

From his surveys and the studies which have been made of the problem during the past few years, it has been deemed best to modify the original project by providing for different works which are believed to be essential to accomplish the desired end.

A map is herewith which shows the general location of the channels, sloughs, and rivers of Tillamook Bay, and near its upper end and upon it are shown the works which have been approved.

The Dry Stocking Dike has been completed, but has not been successful in deepening the channel over the bar there located. This is due to the deflection of water which formerly ran over the bar into other channels. As shown on the map the Trask River has two mouths or forks; one discharging into Hoquarton Slough above Dry Stocking Bar, and one into Tillamook River, which flows into the bay below Dry Stocking.

The first mouth, locally known as North Fork, has become clogged up so with timber jams as to divert most of the water into the South Fork.

It is proposed to remedy the evil by building a dike across the head of the South Fork and removing the jams from the North Fork. It is also proposed to give a stronger flow to the North Fork past Dry Stocking Bar by cutting out a long bend of the fork by means of a dike thrown across it and the enlargement of the artificial channel at Oxbow Bend. It is hoped that by means of these works Dry Stocking Bar will be scoured out and a good channel maintained through it.

The Junction Bar dike is being extended 2,000 feet as indicated.

The condition of Junction Bar is aggravated by the Wilson River. This river has two mouths, and it is proposed to close the upper one in

order that it may unite with the main through channel by its lower mouth only.

The location of the dike to be built, closing the upper mouth, is shown.

Farther down the bay a serious condition exists, which has caused much trouble.

An inspection of the map herewith shows that on the upper part of the bay there are two channels crossing each other, the Main or Garibaldi Channel being crossed by the Kilchis River and a corresponding continuation of it on the west, marked on the map Middle Channel.

It is in the neighborhood of this crossing that vessels find great trouble from shoals and shifting channels. At this place the following work is proposed as part of the general project:

First. To build a dike diagonally across the Kilchis River channel, as shown on the map; its object being to divert the Kilchis into the North or Bay City Channel, enlarging this channel and thus aiding in its union with the upper Garibaldi Channel.

Second. To build a dike across the head of the Middle Channel. The object of this is to unify and concentrate all the flowing water so as to make a deep channel, permanent in location and well directed against the narrow intervening sands between the North Fork and Garibaldi channels.

All the works have been approved as part of the general project.

The completion of the through channel direct to Tillamook City and its improvement in shoal places will be of great convenience to the commercial interests of the bay. It is estimated that the sum of $50,000 can be profitably expended on the project during the fiscal year ending June 30, 1897.

Future operations.—Work will continue under the existing contract as long as the available funds will allow.

Money statement.

July 1, 1894, balance unexpended		$4,003.10
Amount appropriated by act of August 17, 1894		16,000.00
		20,003.10
June 30, 1895, amount expended during fiscal year		2,593.99
July 1, 1895, balance unexpended		17,409.11
July 1, 1895, outstanding liabilities	$150.00	
July 1, 1895, amount covered by uncompleted contracts	12,225.67	
		12,375.67
July 1, 1895, balance available		5,033.44
Amount (estimated) required for completion of existing project		69,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		50,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

COMMERCIAL STATISTICS.

Tillamook Bay is in the collection district of Oregon. Astoria, near the mouth of the Columbia, is the nearest port of entry. The nearest light-house is at Cape Meares, about 4 miles south of the entrance.

The following returns for the fiscal year ending June 30, 1895, were furnished by Mr. J. H. Bridgeford, inspector of customs at Astoria, Oreg.

Shipping.—The number of coastwise vessels arriving at Tillamook Bay during the year was 98; the number of clearances was 98. All were steam vessels with one exception, a schooner.

Maximum draft of loaded vessels was 15.6 feet.

Number of passengers arrived by sea during year, 730; number of passengers departed by sea during year, 672.

The following is a list of steamers plying at regular and irregular intervals between Tillamook Bay and Astoria, Portland and San Francisco:

Name and rig.	Net tonnage.	Draft, loaded.
		Ft. in.
Steam schooner Truckee	295.82	15 6
Steam schooner R. P. Elmore	57.24	7 6
Steamer Augusta	40.90	7 9
Steamer W. H. Harrison	52.86	6 9
Steamer South Coast	209.35	10 5
Steamer Homer	331.02	14 0

Of this list the *Truckee* arrives twice a month from San Francisco and Portland, and the *R. P. Elmore* once a week from Astoria.

The remaining steamers call at the bay only at irregular intervals.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.	*Tons.*		IMPORTS.	*Tons.*	
Lumber (11,600 feet, B. M.)	23,200	$116,000	General merchandise	4,600	$184,000
Salmon (9,500 cases)	333.5	38,000	Agricultural implements	245	4,900
Salmon (130 barrels)	13	1,300	Flour and feed	760	17,300
Eggs (760 cases)	22.8	2,716			
Cheese	160	32,000	Total	5,605	206,200
Butter	235	84,600			
Hides and furs	34	3,400			
Fruit and miscellaneous products	139	6,950			
Total	24,137.3	284,966			

SUMMARY.

	Tons.	Estimated value.
Total exports	24,137.3	$284,966
Total imports	5,605	206,200

River and bay traffic.—The steam tug *General Garfield*, of 10 tons capacity and 5 feet draft, together with the steam launches *Louise* and *Gertie*, ply on the waters of the bay and do a general freight and passenger business.

The steam launch *Gertie* was built on the bay since the date of last report; her tonnage is 3.8 and her draft is 2.5 feet.

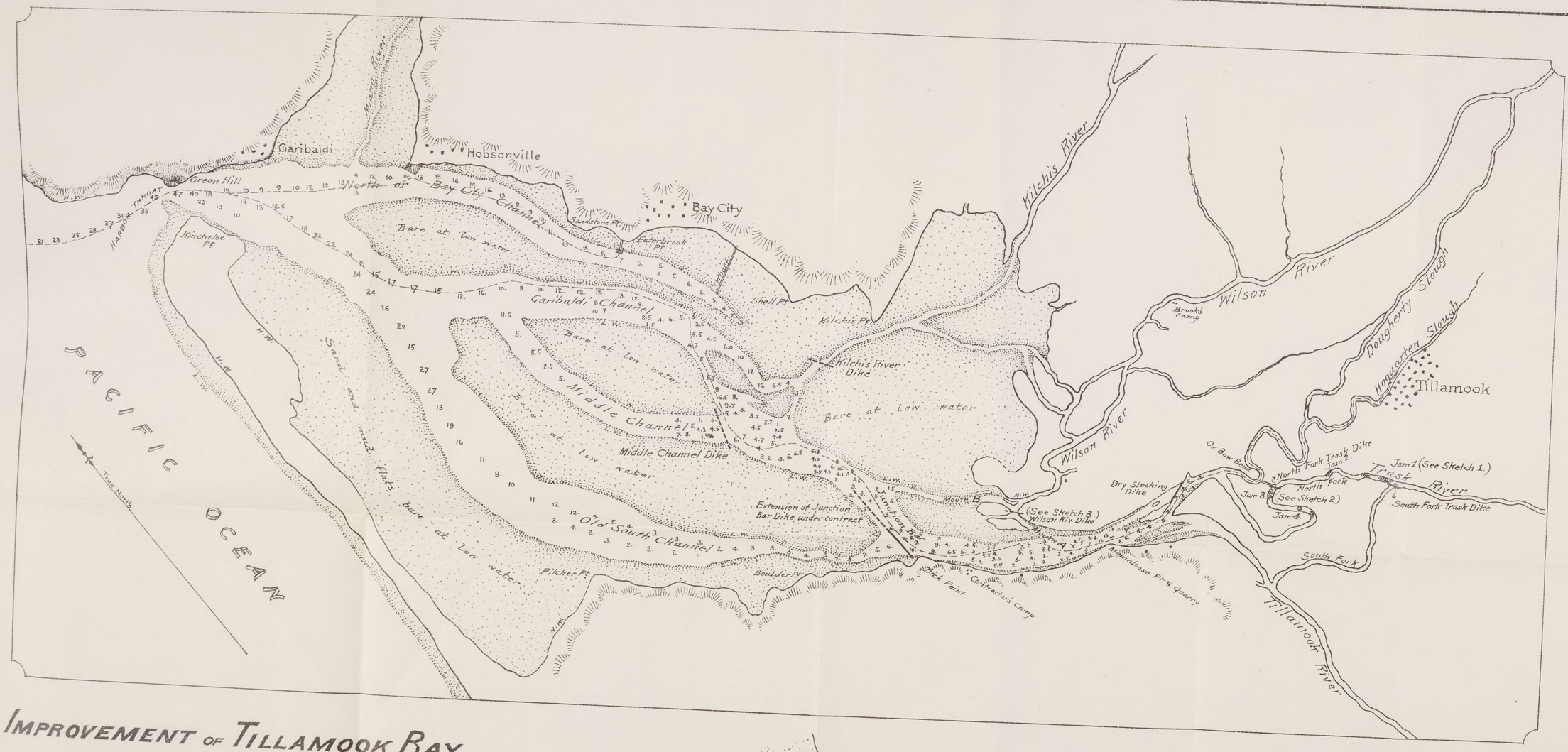
T T 9.

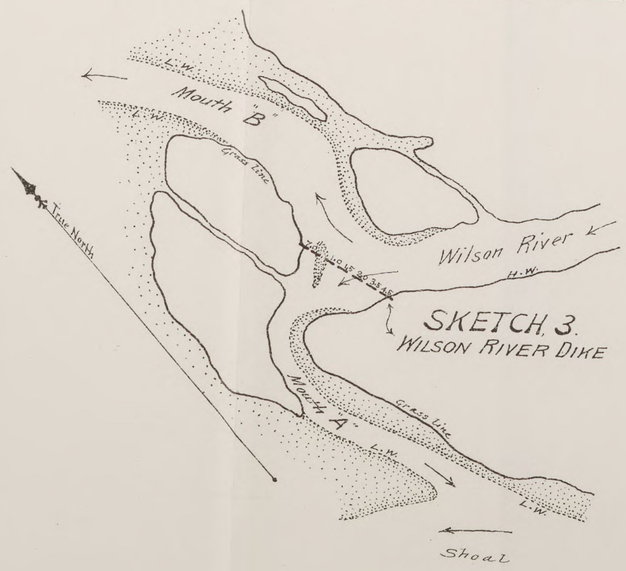
IMPROVEMENT OF ENTRANCE TO NEHALEM BAY, OREGON.

Description of original condition.—Nehalem Bay at high water is about 2 miles long by $1\frac{1}{3}$ miles wide at widest part, and is connected with the ocean by a narrow channel extending in a southerly direction about 3 miles. This channel varies in width from 1,000 to 2,000 feet at high tide. A low sandy peninsula about $2\frac{1}{2}$ miles long and one-fourth mile wide lies to the west of this channel and separates it from the ocean.

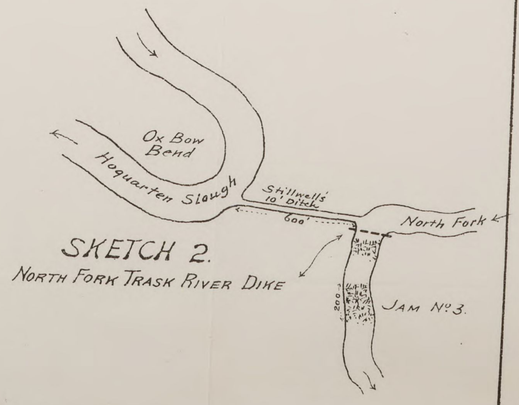
IMPROVEMENT OF TILLAMOOK BAY, OREGON.

1895









Scale for General Map: mile 1, 3/4, 1/2, 1/4, 0, 1, 2 miles

Scale for detail sketches: ft. 1000, 300, 0, 500, 1000, 1500, 2000 ft.

NOTE

Soundings are characteristic only; they are expressed in feet and are referred to low water datum of Junction Bar and Dry Stocking Dikes.
Constructed Dikes are indicated thus: ——————
Dikes in course of construction, and approved location for others, shown thus: - - - - - -
The course of steamer channel is indicated thus: — — — —
Survey and soundings made by David B. Ogden, Asst. Engr. April. 1895.
Mean rise of tide at Junction Bar, 6.8 ft.

APPROPRIATIONS

	#
Act of Aug. 11, 1888	5,200.
Act of Sep. 19, 1890	500.
Act of July 13, 1892	15,000.
Act of Aug. 17, 1894	16,000.
	# 36,700.

PLAN OF IMPROVEMENT.

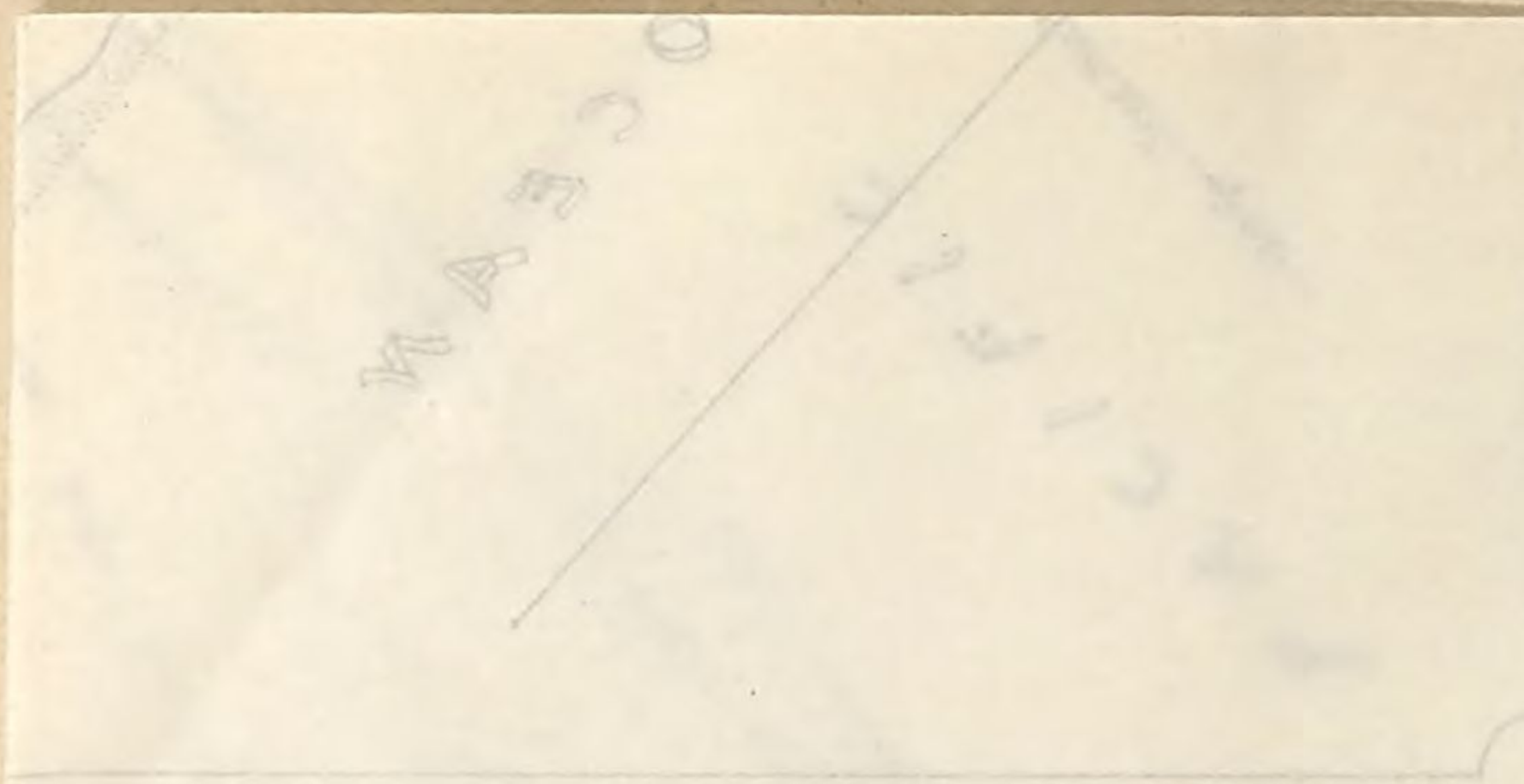
The plan of improvement covered by the existing and approved project is to make a navigable pass from the North to the Middle Channel, and thence up Hoquarton Slough to Tillamook City.

Sent with annual report for 1895

J. W. Symonds

Captain, Corps of Engineers

drawn by A. Downing



The southern end of this peninsula forms the northern shore of the entrance. Between this and the main shore, which limits the entrance on the south, is a distance of 1 mile. The entrance channel shifts within these limits of 1 mile, occupying sometimes a southerly position and sometimes a northerly one, and sometimes there are two channels, separated by a sand island, bare at low water. At the time of survey of June, 1889, a depth of 6 feet was found on the bar at the northern channel. The ordinary bar depth may be stated to be about 5 to 6 feet at low water.

Plan of improvement.—The plan of improvement recommended by Captain Young was to build two high-tide stone jetties converging until the distance apart is about 500 feet, and then, if necessary, running out to sea parallel to each other to such distance as will insure a low-water depth on the bar of at least 8 feet, the north jetty to rest on the end of the sandy peninsula, and the south jetty upon the mainland, the object being to hold the channel in its southerly position.

The cost of the work as estimated by Capt. W. Young, Corps of Engineers, was $325,927.50.

Subsequent estimates made in May, 1891, show that the cost was underestimated, and that the work will cost $712,388.

APPROPRIATION.

Act of September 19, 1890, "for commencement of jetty construction"..... $10,000

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $415.08.

Results obtained to June 30, 1894.—No work other than the making of a survey was done and no results were obtained.

Amount expended during fiscal year ending June 30, 1895.—There was no money expended during the fiscal year ending June 30, 1895. No work was done and no results obtained.

Report of operations.—On July 22, 1892, in accordance with instructions, the money on hand pertaining to the improvement of Nehalem Bay was turned into the United States Treasury. This leaves in the Treasury, available for the work whenever started, $9,584.92.

Recommendations and remarks.—No project for the improvement of the Nehalem having been definitely and formally decided upon, and no work of construction having been authorized or commenced, I refrain from making any recommendations as to future appropriations or as to the amount that could be profitably expended upon the work during the next fiscal year.

Money statement.

July 1, 1894, balance unexpended	$9,584.92
July 1, 1895, balance unexpended	9,584.92

COMMERCIAL STATISTICS.

Nehalem Bay is in the collection district of Oregon. The port of entry is Astoria. The nearest light-house is at Cape Meares, 13 miles distant.

The following returns relative to the commerce of Nehalem Bay and River, for the fiscal year ending June 30, 1895, are furnished by Mr. Edward G. E. Wist, of Nehalem.

Arrivals and departures of vessels.—The number of vessels arriving (coastwise) in the bay during the year was 15; the same number cleared. All were steam vessels; no sailing vessels arrived or cleared.

Maximum draft of vessels, loaded, was 9 feet.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.	*Tons.*		IMPORTS.	*Tons.*	
Box and other manufactured lumber	155	$1,000	General merchandise	600	$30,000
Salmon (in cases)	280	32,000	Cannery supplies	100	8,000
Salmon (in barrels)	5	300	Agricultural implements	42	1,050
Butter	20	8,000	Sawmill machinery	300	15,000
Hides and furs	5	500	Total	1,042	54,050
Beef and veal, dressed	2	150			
Elk horns (20 pairs)	.....	100			
Total	467	42,050			

SUMMARY.

	Tons.	Estimated value.
Total exports	467	$42,050
Total imports	1,042	54,050

The failure of one sawmill and the destruction of the other by fire on the Nehalem Bay since date of last report accounts for the small amount of lumber exports.

T T 10.

IMPROVEMENT OF UPPER SNAKE RIVER, IDAHO, BETWEEN HUNTINGTON BRIDGE AND SEVEN DEVILS MINING DISTRICT.

The first appropriation for this work was made in the river and harbor bill approved July 13, 1892.

Description of original condition.—The Snake River from the Huntington Bridge to the Seven Devils mining district flows through a deep canyon, and is a river generally swift, broken by rapids and studded with rocks, rendering navigation practically impossible. The bed and banks of the river are generally of hard basaltic rock and granite.

Plan of improvement.—The plan of improvement consists in removing obstructing rocks and reefs from a selected channel 150 feet wide and putting in ringbolts and iron posts for the convenience of loaded boats lining up over the worst rapids. The estimated cost of the work is $80,000.

APPROPRIATIONS.

Act of—	
July 13, 1892	$20,000
August 17, 1894	25,000
Total	45,000

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $19,251.12.

Results obtained to June 30, 1894.—The results obtained to June 30, 1894, were the removal of a large amount of rock from the upper portion of the river next below Huntington Bridge.

Amount expended during fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $13,696.31.

Results obtained during the fiscal year ending June 30, 1895.—A practicable channel was opened by rock removal to the head of Shoo Fly Rapids, about 2½ miles farther downstream than the point where the work started.

Report of operations.—The drill scows had been laid up at moorings on Snake River for nineteen months in charge of a watchman. During this time the planking of sides and rakes of bow and stern above water level had shrunk, opening the seams. Numerous seams had opened in the decks, the cabins had been somewhat deranged by the high winds, and the skiffs were in a leaky condition.

Repairs were commenced September 13, 1894, and on the 17th those on the scow *Oregon* were so far completed that it was put into service at rock drilling. Repairs on the scow *Idaho* were completed on the 24th, and that scow was put into service.

The work of drilling and blasting was continued until February 25, 1895, when, owing to conditions of river unfavorable to further prosecution of the work, the scows were withdrawn to moorings, and the work closed for the season.

During the progress of the work the scows and equipment were kept in repair, and at the close left in condition efficient for immediate service.

From the beginning of the work until near the end of December the conditions of river and weather were very favorable for the prosecution of the work. On December 14 a period of low temperature set in, followed by the formation of slush ice in the river. This, with occasional runs of heavy ice, continued with some intermissions until the work was closed. At a number of places in the river the ice gorged for a few days at a time.

The cold weather and the ice interfered at times with the prosecution of the work.

Work was commenced this season on the reef a short distance above Whisky Point, where work was left unfinished at the close of the previous season's work, in February, 1893, and closed at the end of the season at the head of Shoo Fly Rapids, 2½ miles farther downstream. Over this reach a channel of a least width of 80 feet was opened to a depth of at least 4 feet, except on a reef immediately below Eagle Rock, near the lower end of the reach, the completion of the work on which was deferred until next season. At all places where rock removal was made the rock was disposed of, where practicable in deep water. Where this was not practicable, on account of the absence of deep water in the immediate vicinity, the rock was, by a liberal use of giant powder, broken up into small fragments and scattered as well as possible, or left on the spot to be carried away by the freshets. At two places only was the channel thus left obstructed, one a short distance above Whisky Point and the other about a quarter mile above Hawks Beak Point. From the effect of the current in removing similar obstructions left at the close of the previous season's work, I have reason to suppose that these will be removed by the increased current due to the freshets.

Owing to the limited appropriation available, the work on the channel through the rapids was limited to the removal only of such obstructions as altogether barred the passage of boats or seriously endangered them, the object being to open the river fairly well to navigation to the landing for the Seven Devils mining district, 65 miles below Huntington Bridge, with the present appropriation, leaving the channel to be further improved in the future.

At the close of the season's work the plant was moored on the right bank of the river, about one-half mile below Eagle Rock, and placed in charge of a watchman.

The following is a condensed statement of the result of the season's work:

Number of holes drilled		470
Total length of holes	feet	2,461½
Holes loaded and fired		450
Holes lost		20
Explosives used	pounds	4,066
Rocks removed	cubic yards	1,858

The work throughout the year has been in charge of Mr. P. G. Eastwick, assistant engineer.

Recommendations and remarks.—The steamer *Norma*, which was built for running on this portion of the river, made but one attempt at running. This was in the summer of 1892, before the work of improvement commenced. This trip apparently convinced her owners that the navigation of the river in its natural condition was impracticable, and she remained tied up at Huntington Bridge until the month of May, 1895. Her owners then apparently gave up all idea of her ever being able to run on the river in a commercially successful manner, and during the high water in May, 1895, she was run down through the canyon of the Snake River to Lewiston, and will hereafter be employed on the lower river.

This abandonment dispels all immediate hope of any use being made of the river for purposes of navigation.

There is absolutely no commerce carried on on the river and no great hope that there will be any in the near future.

It is possible that, after the river between Huntington and the Seven Devils mining country is improved as far as practicable by regularization, there may be some navigation on it. The navigation of the river must, however, always be difficult and dangerous, in spite of all that can be done. If it is decided to continue the work an appropriation of $20,000 can profitably be expended on the project.

Future operations.—When the water goes down work of rock removal with the money available will be resumed.

Money statement.

July 1, 1894, balance unexpended	$748.88
Amount appropriated by act of August 17, 1894	25,000.00
	25,748.88
June 30, 1895, amount expended during fiscal year	13,696.31
July 1, 1895, balance unexpended	12,052.57
July 1, 1895, outstanding liabilities	25.00
July 1, 1895, balance available	12,027.57
Amount (estimated) required for completion of existing project	35,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

There is no commerce on this portion of the Snake River.

T T 11.

IMPROVEMENT OF UPPER COLUMBIA AND SNAKE RIVERS, OREGON AND WASHINGTON.

Description of original condition.—Under the above head it has been deemed proper to officially include the continuous Columbia and Snake rivers from Celilo, Oreg., at the head of The Dalles, to Asotin, Wash., situated on the Snake about 7 miles above its junction with the Clearwater.

The upper Columbia and Snake form a continuous line of navigable river, broken by many rapids, which render navigation difficult and dangerous. These rapids are in nearly every instance caused by rocky bars with occasional bowlders, and the channels are crooked and narrow.

Before improvement, the ruling depth of many of these bars was 2 to 3 feet at low water; some were practically impassable at low water.

The Columbia was navigable all the year round, except when closed by ice. The Snake was, however, only navigable during high water during three or four months in the spring of the year.

Plan of improvement.—Previous to 1877 $120,000 had been appropriated for the work of improvement, and had been expended in surveys and rock removal at the principal rapids.

In 1877 Maj. J. M. Wilson made a project for the improvement of the upper Columbia and Snake rivers, which consisted in the removal of rock bowlders and rocky reefs and the scraping of gravel bars in the Columbia and Snake as far up as Lewiston. The estimated cost of this work was $132,000.

The present project or plan of improvement consists in the removal of bowlders, gravel bars, and rock ledges and the construction of such contraction works as may be necessary.

The estimated cost of the work has not yet been accurately determined because of the lack of full and continuous surveys, and because from the nature of things it can not be, as many of the obstructions which it is necessary to remove are continually recurring.

By the terms of the river and harbor act of July 13, 1892, the upper limit of work under this head was extended from Lewiston, Idaho, to Asotin, Wash., a distance of 7 miles.

APPROPRIATIONS.

Upper Columbia River, act of—	
June 10, 1873	$50,000
June 23, 1874	20,000
March 3, 1875	35,000
Total	105,000
Upper Columbia and Snake rivers, act of—	
August 14, 1876	15,000
June 18, 1878	20,000
March 3, 1879	20,000
June 14, 1880	15,000
March 3, 1881	15,000
August 2, 1882	6,000
July 5, 1884	20,000
August 5, 1886	10,000
August 11, 1888	10,000
September 19, 1890	20,000
July 13, 1892	15,000
August 17, 1894	5,000
Total	171,000
Aggregate	276,000

Amount expended to June 30, 1894.—The amount expended on the project to June 30, 1894, was $165,554.52.

Results obtained to June 30, 1894.—The results obtained to June 30, 1894, were the effective removal of the most obstructive rocks and reefs between Riparia and Asotin.

Prior to 1880 much work had been done in removing obstructions to the rapids of the Columbia River between Celilo and the mouth of the Snake, and until 1882 on that part of the Snake below Riparia.

The completion of the Oregon Railway and Navigation Company's line of railroad and a small section of the Northern Pacific, which parallel the Columbia from Celilo to the mouth of the Snake, and cross the Snake at Riparia, has caused the navigation by steamers of these two rivers from Celilo to Riparia to be abandoned.

The further improvement being unnecessary, no work was done on the reaches below Riparia subsequent to the dates above mentioned.

Besides the work of rock removal, dikes were built, in accordance with the approved project, at Wild Goose Island and Log Cabin Rapids. These dikes have not yet been fully completed.

Amount expended during the fiscal year ending June 30, 1895.—The amount expended during the fiscal year ended June 30, 1895, was $841.47.

Results obtained during fiscal year ending June 30, 1895.—Nothing having been done during the fiscal year, no further results have been attained.

Report of operations.—The only operations carried on during the year were the protection and care of public property connected with the work. The boats and all property were kept at Lewiston, Idaho, under charge of a watchman. A portion of the plant on hand was borrowed for work on the upper Columbia, between Rock Island and Foster Creek Rapids.

Recommendations and remarks.—The expense attendant upon starting up work on the river, getting boats ready and towed to the scene of operations, collecting a force of men and materials, and the reverse of this when work ceases is so great that with the small amount of money available it was not deemed best to expend it in carrying out the project. Unless some bowlders appear or the river from Raparia to Asotin gets worse in some particulars it will be in the interest of economy to hold the balance available until enough more can be added to it to justify the starting of work on the dikes. The river between Riparia and Asotin is an important highway of commerce. Besides the permanent work of dike construction and regularization, there is and always will be required on this river work of a temporary character consisting of the removal of water and ice borne bowlders which lodge in the shallowest parts of the channel and become dangerous obstructions, which, even if known and avoided, limit materially the loads that can be carried on the steamboats plying on the river. The work done on the river between Lewiston and Asotin in removing these bowlders has doubled the carrying capacity of the steamers employed.

The dikes should be completed as soon as practicable, and it is recommended that an appropriation of $20,000 be made for the Upper Columbia and Snake, as this amount can be profitably expended during the fiscal year ending June 30, 1897.

Future operations.—Future operations with the existing appropriation will depend upon the condition of the river when the water goes down to its lowest stage.

Money statement.

July 1, 1894, balance unexpended	$445.48
Amount appropriated by act of August 17, 1894	5,000.00
	5,445.48
June 30, 1895, amount expended during fiscal year	841.47
July 1, 1895, balance unexpended	4,604.01
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1897	20,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The following returns are furnished by Mr. T. W. Lee, superintendent of water lines, Oregon Railway and Navigation Company.

Shipping.—Following are the names of steamboats operated by the Oregon Railway and Navigation Company upon Snake River, between Riparia and Lewiston, during the fiscal year ending June 30, 1895, together with their tonnage, draft, and amount of freight carried.

Name.	Net tonnage.	Draft, loaded.	Freight carried.
		Feet.	*Tons.*
Lewiston	487.60	4½	.....
Almota	395.24	4½	37,000
Spokane	531.68	4	.....

SUMMARY.

Total amount of freight carried	tons..	37,000
Estimated value of same		$1,240,000
Number of passengers carried during year		1,530

Nature of freight: Merchandise, grain, fruit, and vegetables.

T T 12.

IMPROVEMENT OF COLUMBIA RIVER BETWEEN HEAD OF ROCK ISLAND RAPIDS AND FOOT OF PRIEST RAPIDS, WASHINGTON.

Description of original condition.—The portion of the Columbia from the head of Rock Island Rapids to the foot of Priest Rapids is about 60 miles in length. The river flows generally through a deep canyon. The banks for the greater part of the way are nearly precipitous bluffs from 1,000 to 3,000 feet high, composed of columnar black basalt. The country bordering the river is rocky and sterile.

The principal obstructions to the navigation of this portion of the river are Rock Island, Cabinet, and Priest rapids.

At Rock Island Rapids the river has cut around both sides of a large island of rock. The channel, however, on each side is very much obstructed with reefs, rocks, and points sharply projecting from the shore. The result is a waterway so much restricted at all stages as to dam up the waters to the extent that they escape over lines of very steep slope and amidst great masses of reef, rocks, and high projecting islands. A great reef is found a short distance above the head of the island which has caused extensive deposits of gravel, nearly choking the channel at low water. The river here has a fall of 10 feet in 3,000

feet, and 12½ feet in 8,000 feet at a stage, as nearly as can be ascertained, of 4 feet above dead low water.

At Cabinet Rapids a mass of basaltic rock projects from the left shore nearly two-thirds across the channel of the river, deflecting the current and causing it to impinge upon the nearly vertical rocks of the right bank. Other masses of rock exist in the channel in and about the main rapids. The fall here is 10 feet in a distance of 8,000 feet. At Priest Rapids there are seven principal rapids extending over a length of 10 miles of river. The total fall in this distance is, at low water, 72 feet, and at high water about 63½ feet.

In all these rapids the river runs through and over hard, rough, and jagged basaltic rocks.

Plan of improvement.—The plan of improvement under which work has been carried on consists in removing obstructing rocks and reefs at Priest, Cabinet, and Rock Island rapids, and putting in at all locations where they would be convenient iron posts and ringbolts to which ascending boats could make fast their lines and then wind themselves up over the rapids by means of their steam capstans, with which all such boats would properly be provided.

The estimated cost of the work proposed was $550,000, but subsequent study and consideration are convincing to the fact that neither this nor any other sum in reason will be sufficient to attain the object aimed at—of giving a commercially practicable navigation past these obstructions under the existing plan and project.

In addition to this a survey of the Columbia from the head of Rock Island Rapids to the international boundary line was authorized and has been completed.

APPROPRIATIONS.

Act of September 19, 1890, $70,000, of which $10,000, or so much thereof as may be necessary, may be used in the survey of the Columbia River from the international boundary line to Rock Island Rapids.

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $61,989.39, divided as follows:

For survey of river from international boundary line to Rock Island Rapids	$10,000.00
For improvement of river at Priest, Cabinet, and Rock Island rapids	51,989.39

Results obtained to June 30, 1894.—At Priest Rapids a large amount of rock had been removed from the channel selected for improvement, without, however, benefiting navigation to any marked degree.

At Cabinet Rapids a number of projecting rocks along the right bank had been removed, and some rocky island masses near the left bank were honeycombed with drifts and drill holes, loaded with dynamite, and blasted, dividing the rock into small fragments, which were washed away by subsequent high waters.

A number of ringbolts have also been put in at various points along the river for convenience of boats lining over the rapids, should they attempt it.

The work at Rock Island Rapids was conducted with the object of removing from the right bank obstructions which interfered with boats in lining up during the higher stages of the river, and which endangered them in running down.

The work which has been done at Cabinet and Rock Island rapids would be of benefit to navigation if any existed.

The survey of the river from the international boundary line to the mouth of the Okanogan was completed.

Amount expended during fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $5,385.31. Of this amount $5,379.90 was expended on the improvement of the Columbia River from Rock Island Rapids to Foster Creek Rapids, Washington, as authorized by the river and harbor act of August 17, 1894. The remainder, $5.41, was expended prior to the passage of that act in connection with office expenses and care of property.

Results obtained during fiscal year ending June 30, 1895.—As no work was done to the river between the head of Rock Island Rapids and the foot of Priest Rapids in the way of improvement, the results obtained do not vary from those above reported.

The survey authorized by the appropriation has been completed and the results published.

Recommendations and remarks.—I desire to invite attention to the statements under this head in my annual report for 1891 on the "Upper Columbia from the head of Rock Island Rapids to the foot of Priest Rapids" and the "Upper Columbia and Snake," pages 3212 and 3226, Report to Chief of Engineers.

As the improvement of this river by any system of regularization to give practical navigation appears to be chimerical, and as there is no navigation of the river, no further appropriation is suggested for the work.

Attention is invited to the fact that by the terms of the river and harbor act of August 17, 1894, the money remaining from this appropriation is made available for improving the stretch of river from Rock Island Rapids to Foster Creek Rapids. This is considered as a final abandonment of the project between the head of Rock Island Rapids and the foot of Priest Rapids.

Money statement.

July 1, 1894, balance unexpended	$8,010.61
June 30, 1895, amount expended during fiscal year	5,385.31
July 1, 1895, balance unexpended	2,625.30

COMMERCIAL STATISTICS.

There is no commerce of any kind on the portion of the Upper Columbia from the foot of Priest Rapids to the head of Rock Island Rapids.

T T 13.

IMPROVEMENT OF COLUMBIA RIVER FROM ROCK ISLAND RAPIDS TO FOSTER CREEK RAPIDS, WASHINGTON.

This is a new stretch of the Columbia River, the improvement of which has never hitherto been provided for, and it is deemed proper to report upon it separately.

Description of original condition.—This portion of the river is 80 miles in length. It flows through a deep canyon with an average fall of 2.2 feet per mile. The river has sufficient water for all purposes of navigation, and the only difficulties in the way of navigation are:

1st. The generally swift currents.
2d. Rocks here and there which occupy dangerous and unknown positions, and
3d. The rapids at the Methow, Entiat, and Wenatchee Rivers.

The river is navigated from the mouth of the Okanogan, which is practically at Foster Creek Rapids, down to Wenatchee, where connection is made with the Great Northern Railroad.

Plan of improvement.—During the season just passed a survey with project for improvement of this portion of the river was made. This has been the subject of a special report, but has not yet been finally adopted.

In the meanwhile a temporary project of improvement was made, based upon a preliminary examination. The project contemplates the removal of obstructive rocks at Rocky Reach and Methow Rapids and at such other places as may be found necessary. Also to put in deadmen or other suitable anchorages as points of support for lining up at Entiat and Methow Rapids, and to put in a timber boom at Entiat Rapids. This boom is designed to enable boatmen to carry a line to a deadman located on an island conveniently situated for boats lining up over the rapids.

Appropriation.—The river and harbor act of August 17, 1894, contained the following item:

> The Secretary of War may, in his discretion, expend the unexpended balance, eight thousand two hundred and ten dollars and ninety-two cents, of the appropriation heretofore made for the improvement of the Columbia River between the head of Rock Island Rapids and the foot of Priest Rapids, Washington, for the building of a snag boat for use on the Columbia River between Rock Island Rapids and Foster Creek Rapids, and for such other work as may be necessary for the improvement of navigation of said river within the above named limits.

At the time of the passage of the bill, this amount had been reduced to $8,005.20.

Amount expended during the fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $5,379.90.

Results obtained during the fiscal year ending June 30, 1895.—The results obtained to June 30, 1895, were the removal of a considerable amount of rock at Rocky Reach and at the Methow Rapids, thereby benefiting navigation, and the completion of a project for improving ordinary navigation through Entiat Rapids.

Report of operations.—Mr. C. F. B. Haskell was designated to take charge of the work, and he commenced active operations on February 20, 1895. The remainder of February was consumed in organizing a working force and assembling the requisite plant at Wenatchee. A small steam ferryboat was hired and put in condition for quartering the working force, and for working on the obstructive rocks. A steam drill was supplied and the tools and appliances were mostly supplied by borrowing from other appropriations.

During March the whole outfit moved to Rocky Reach and proceeded with the work of rock removal. This continued all the month.

During April the river got too high to work advantageously at Rocky Reach, and the outfit moved to the Methow Rapids. Here the work progressed very satisfactorily until May 20, when an accident occurred by which Mr. Haskell, Mr. Barton, one of his best workmen, and a lady, Mrs. Prowell, lost their lives by drowning in the Methow Rapids.

Mr. Phillip G. Eastwick was sent up to assume charge of the work. Work continued under his direction until June 12, when the high water caused a cessation of operations. The boat was dispensed with, the force disbanded, and the property and tools stored at Wenatchee. The end of the fiscal year, June 30, 1895, saw all operations suspended.

Recommendations and remarks.—The improvement of this stretch of river having been made the subject of a special survey and report, it is

not considered necessary to make any recommendation as to further appropriations here.

Future operations.—When the water goes down in the fall, it is expected to build the boom for the Entiat Rapids and to put in the deadmen posts, etc. After this is completed, any money left over will probably be expended in rock removal.

Money statement.

The unexpended balance of the appropriation for the improvement of the Columbia River between the head of Rock Island Rapids and the foot of Priest Rapids, made available for the work by the river and harbor act of August 17, 1894, was $8,005.20. Of this amount $5,379.90 has been expended, leaving a balance available of $2,625.30.

REPORT OF MR. PHILLIP G. EASTWICK, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., June 20, 1895.

SIR: I have the honor to submit the following report of operations upon the improvement of the Columbia River from Rock Island Rapids to Foster Creek Rapids, Washington, during the past season:

The work was commenced in February, 1895, under the local charge of Mr. C. F. B. Haskell, assistant engineer, and continued by him until May 20, 1895, when he was accidentally drowned at Methow Rapids. I was immediately assigned to the charge of the work, and arrived at Methow Rapids on May 27, the work during the interval being carried on under the charge of the foreman. The work continued until June 12, when, the high water precluding further operations, it was closed down and the force discharged.

As the Government owned no scow that was available for the work, the steam ferry-boat *Wenatchee* was hired for use on the work. This boat was put into a condition suitable for the work on hand by making needed repairs and fitting it with rudders and with quarters suitable for twenty men. This work was completed by March 9.

It had been decided to confine all work during the season to three obstructions on the river, namely, Rocky Reach, Entiat Rapids, and Methow Rapids.

Work at Rocky Reach was commenced March 11. This involved the removal from the channel of several submerged rocks and a part of a reef dangerous to steamboat navigation at low water, and the breaking up and the scattering of many large bowlders on the left bank, which in high water prevented steamers from taking advantage of the slower current found there.

Three submerged rocks and a considerable part of the submerged reef were removed from the low-water channel. The reef proved to be much more extensive than earlier examinations had indicated. It was quite effectually shattered by a liberal use of giant powder in drill holes and sack shots. Many of the large fragments were removed by grappling hooks and chain slings, aided by the use of the steamboat, and some of the reef was broken into small fragments and scattered by the powder. Twelve holes, having an average depth of 3 feet 7 inches, were drilled in this reef, loaded with powder, and fired. In addition to this, numerous sack shots were fired.

Sixty holes, of a total length of 175 feet 8 inches, were drilled in bowlders along the shore and the bowlders blasted.

The amount of rock removed from the reef and shore at Rocky Reach is estimated at 613 cubic yards.

When work at Rocky Reach was begun the water was about 3 feet above its ordinary low-water stage. During the progress of the work it rose gradually. Owing to the rising water the work at this place was necessarily temporarily abandoned at the close of March. Work at this place can only be advantageously done when the water is near to lowest.

On April 1 the steamer engaged on the work was started up the river. Owing to the inefficient speed of the steamer and the strong currents encountered, which necessitated a resort to lining, the progress was slow. The journey to Methow Rapids occupied eight days, four of which were spent in getting up to the mouth of the Entiat River, over a reach where swift water prevails.

The improvements contemplated at Methow Rapids include the removal of as much as possible of Islands A and B and the Point C, at and near the left bank, near the head of the rapids; the removal of bowlders over a distance of 800 feet from the right bank in the vicinity of Point D, near the foot of the rapids, and the grading of a trail or runway at the same place for the use of steamboat men in leading forward their assisting lines when at high water they are compelled to line up over that part of the rapids. In addition to the work of rock removal, ringbolts are to be placed in suitable places for use when lining up the rapids.

The localities named are shown on the map of survey made last winter by Mr. C. F. B. Haskell, assistant engineer.

At Island A 8 holes, having a total length of 44 feet 6 inches, were drilled and loaded, and 182 cubic yards of rock removed, lowering the island 11 feet.

At Island B 34 holes, having a total length of 135 feet 5 inches, were drilled and loaded, and 524 cubic yards of rock removed, lowering the island 10 feet.

Some time was spent at these islands in removing the broken rock into deep water.

At Point C, locally known as the Fish Trap, work was commenced on the outer end and continued near the shore as the water rose; 103 holes, having a total length of 575 feet, were drilled and loaded in the ledge rock of this point, and 1,132 cubic yards removed. In addition to this, about 300 cubic yards of loose bowlders, which did not require blasting, were removed.

It is estimated that from 4 to 6 feet depth of rocks was shattered on this point, which, owing to the high water prevailing, could not be removed at the time. It is quite probable that some of this will be removed to deep water by the strong currents prevailing at high water. At the root of the point the ridge of Point C was lowered 7 feet. At the outer end a greater abatement was made, but owing to high water its extent could not be ascertained.

At Island B and Point C crevices and potholes in the rock were loaded and fired. When the conditions were favorable the results were eminently satisfactory, and were attained at a much less cost than by drilling.

The rising waters stopped work at Point C, and it was necessary to leave this in a very unfinished condition.

On May 14 work on the left bank at the head of Methow Rapids was closed and the plant removed to the foot of the rapids on the right bank below Point D. Here the bank of the river for a length of 800 to 900 feet immediately above the then prevailing water line, and as far below the water line as was accessible, was cleared of all large bowlders and the surface so smoothed down that steamers could line up without danger of contact with bowlders.

A trail, or runway 925 feet long, for use of the steamboat men in carrying lines ahead, was made at this place.

There were removed from the beach at and near Point D 271 bowlders, most of them large, aggregating 1,304 cubic yards.

In addition to the work of rock removal, ringbolts were placed at the Methow Rapids for use in lining up past the points D and C.

The work having been completed at Methow Rapids to the extent permitted by the stage of the water, and high water precluding further work, the work was closed on June 12, the property stored, and the force discharged.

The amount of rock removal during the season's work sums up as follows:

	Cubic yards.
Rocky Reach	613
Methow Rapids:	
Island A	182
Island B	524
Point C	1,432
Point D	1,304
	3,442
Total	4,055

The project of improvement includes the construction of a boom about 600 feet long, made of square timbers of short sections, to be placed at Entiat Rapids for use as a runway for steamboat men in leading lines ahead, and it was first intended to construct this before closing down work for the season. As, however, the boom would not be required for use until low water, late in the fall, and as at that time its construction could be made to better advantage, its construction was deferred until the resumption of work next season.

In its present condition the principal obstructions to the navigation of the river are at Rocky Reach, Entiat Rapids, and Methow Rapids.

At Rocky Reach work on the removal of the submerged reef should be continued. The extent of this work can not be estimated until after a further examination at

low water. The navigation is badly impeded here at low water by this submerged reef.

At Entiat Rapids no reasonable expenditure of money applied to rock or gravel removal will improve it. A boom, to be used as a runway for use in leading lines ahead, is in contemplation. This boom is required only at low water. As it can be most economically built on the island to which it is to be anchored, and as that island is submerged at high water, its construction is preferably deferred until the abating waters leave the island uncovered.

At Methow Rapids the ridge extending from Point C calls for much additional work to reduce it about 7 feet below the present level. When this is done it is believed that lining will not have to be resorted to at any stage.

The removal of the rock ridge putting out from the left bank opposite the Point D is worthy of consideration. The top of the ridge is but a few feet submerged at high water, so that the cross-sectional area at high water is but little increased over that of low water. The result is a strongly intensified current at that place at high water. The removal of a large part of this reef will, it is believed, so far reduce the intensity of the current as to do away with the need of lining at this place.

An approximate estimate of the quantity of rock to be removed from this ledge is 12,000 cubic yards.

Very respectfully, your obedient servant,

PHILLIP G. EASTWICK, *Assistant Engineer.*

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following information relative to the commerce of this portion of the upper Columbia River for the fiscal year ending June 30, 1895, was furnished by Mr. C. F. B. Haskell, late assistant engineer in local charge of works:

One steamboat, the *City of Ellensburg*, connects with the Great Northern Railway at Wenatchee, and runs to Virginia City, near the mouth of Okanogan River, 64½ miles, making two round trips each week. Nature of cargo carried on upper-river trips, general merchandise; nature of cargo carried on down-river trips, ore and grain.

Average amount of freight carried on round trip	tons..	80
Total amount of freight carried by steamer during year	do....	6,000
Estimated value of same		$180,000
Total number of passengers carried during year		1,350

Extensive gold and silver mining on Squaw and State creeks has been undertaken since date of last report. The results so far are promising. The former creek is a tributary of the Methow River, and the latter rises on the western slope of the divide separating the Methow and Skagit rivers.

T T 14.

IMPROVEMENT OF WILLAPA RIVER AND HARBOR, WASHINGTON.

The first appropriation for this work was made in the river and harbor act approved July 13, 1892.

Description of original condition.—Willapa Harbor, formerly known as Shoalwater Bay, connects with the Pacific Ocean 28 miles to the north of the entrance to the Columbia River. The only portion of the harbor to which any consideration in the way of improvement has been given is that in the vicinity of South Bend, the principal city of the harbor, and the terminus of the railroad from the main line of the Northern Pacific at Chehalis.

South Bend is situated very near the mouth of the Willapa River. Just at the upper limits of the town the river divides itself into a main channel, and a secondary channel; the latter known as Mailboat Slough. This division of the waters caused bars to form in the main channel at

both the upper and lower ends of the slough. There were also several bars in the river proper between South Bend and Willapa City.

Plan of improvement.—The plan of improvement adopted consists in building a dike of piles, brush, and stone across the head of Mailboat Slough, in order to concentrate the ebbing and flooding currents into the main channel, and thereby produce as great a scour as possible on the shoals at the head and foot of the slough. Also to dredge a channel 100 feet wide and 8 feet deep at low water through the reef just below Willapa City, and to close Louderback Slough with a pile, brush, and stone dike with the object of compelling the currents to scour a channel through the bar in the river at its lower end. The estimated cost of the work is $31,350.

The project of August 29, 1894, approved by the Chief of Engineers, also provides for cutting a channel through the log jam of North River, a tributary of Willapa Harbor.

APPROPRIATIONS.

Act of—	
July 13, 1892	$18,000
August 17, 1894	13,350
Total	31,350

The language of the act of August 17, 1894, in making this appropriation, is as follows:

> Improving Willapa River and Harbor, Washington: For completion, thirteen thousand three hundred and fifty dollars: *Provided*, That in the discretion of the Secretary of War two thousand five hundred dollars of the amount appropriated hereby for said river and harbor may be used in removing obstructions in North River

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $17,501.38, of which $6,318.73 was expended in building the Mailboat Slough Dikes, and $11,182.65 in the work of excavating the shoal bar below Willapa City.

Results obtained to June 30, 1894.—The Mailboat Slough Dikes had been completed at the close of the last fiscal year, and a channel was completed through the Willapa City Shoal. This channel was not completed to the full width called for by the project, owing to the lack of funds.

The building of the Mailboat Slough dikes compelled a much stronger current in the main river along the South Bend water front and a deepening of the water over the bar at the lower end of the slough.

Soundings taken when the dike was completed show a deepening of the water over this bar, already brought about by the action of the dike, and a marked widening of the deep channel across it.

Amount expended during fiscal year ending June 30, 1895.—The amount of money expended during the fiscal year ending June 30, 1895, was $3,168.56. Of this amount $3,081.51 was expended on improving Willapa River, and $87.05 on the improvement of the North River.

Results obtained during the fiscal year ending June 30, 1895.—The dike work in the harbor and river was completed, and the work of dredging through the shoal just below Willapa City was in progress at the close of the fiscal year.

No survey has yet been made to determine the effect of the Louderback Slough Dike.

The work of removing the log jam in North River was also under way at the close of the fiscal year, and it is expected that it will be finished in July, as far as practicable, until the fall freshets come to help the débris along on its way to the sea.

No survey has been made to determine accurately the deepening of the channel at South Bend, but, from general repute, it may be stated that the work done has been successful in materially benefiting the channel.

It having been decided to attempt to do the North River work by contract, specifications were prepared and the work was advertised December 4, 1894. Bids were opened December 15, 1894.

The following is an abstract of the bids received:

No.	Name and address of bidder.	Making channel—		Total.
		100 feet wide.	50 feet wide.	
1	Marshall C. Rudder and Isaac M. Kelley, South Bend, Wash	.....	$2,175	$2,175
2	Geo. T. Hitchcock, Portland, Oreg	$1,980	.....	1,980

For reasons stated in my letter of December 17, 1894, the bid of George T. Hitchcock was rejected and the contract awarded to Rudder & Kelley.

The contractors commenced operations about April 1, 1895, and the work was in progress at the close of the fiscal year.

Under date of December 10, 1894, the work of dike building and repair, and dredging in Willapa Harbor and River, was advertised. The bids were opened January 12, 1895, and the following is an abstract of those received:

No.	Name and address of bidder.	Piles, per linear foot.	Lumber, per M feet, B. M.	Bolts, each.	Spikes, per pound.	Brush, per cord.	Wire, per pound.	Stone, per ton.	Dredging, per cubic yard.	Total.	
										Dike building.	Dredging.
		Cts.		*Cts.*	*Cts.*		*Cts.*	*Cts.*			
1	Chas. P. Church, Portland, Oreg	.....	.....	.....	.....	.....	.....	.....	$2.95	.....	$2,360.00
2	James Francis Case, Portland, Oreg	10	$12.50	18	3½	$2.28	3 1/10	60	3.09	$2,483.00	2,472.00
3	Chas. L. Stanley, Wm. B. Murdock, and William R. Gray, South Bend, Wash	18	10.00	35	4½	3.00	6	115	3.50	3,702.50	2,800.00
4	Marshall C. Rudder, South Bend, Wash	11	13.50	70	7	3.50	10	70	2.74	3,567.00	2,192.00
5	Chas. O. Rude, South Bend, Wash	8	10.00	20	4	2.45	4	60	2.74	2,500.00	2,192.00
6	Chas. Ewing, Portland, Oreg	10	14.00	17	3½	2.48	3½	65	.....	2,665.50	.....
7	Cameron & Robertson, Portland, Oreg	10	15.00	30	5	2.35	5	75	.....	2,732.50	.....
8	Anthony A. Werley, South Bend, Wash	10	10.00	20	3	2.25	3	60	4.44	2,430.00	3,552.00
9	Dickinson & Co., Tacoma, Wash	8½	11.00	18	3¼	2.35	3¼	60	3.35	2,447,50	2,680.00

The contract for the dredging was awarded to Charles O. Rude, of South Bend, and for the dike building to Dickinson & Co., of Tacoma, Wash.

The work of dredging was not commenced until June, 1895. Operations connected therewith were under way at the close of the fiscal year.

Operations in repairing the Mailboat Slough dikes and building the Louderback Slough Dike were commenced April 1, and the work was completed May 31, 1895.

The work was under the personal charge of Mr. John Zug, whose report as to details is herewith.

Recommendations and remarks.—The money appropriated will fully complete the work called for by the project, as well as make the requisite channel through the North River jam.

Such being the case, no further estimate is submitted.

Future operations.—Work will continue until all that which is called for by the project is completed.

Money statement.

July 1, 1894, balance unexpended		$498.62
Amount appropriated by act of August 17, 1894		13,350.00
		13,848.62
June 30, 1895, amount expended during fiscal year		3,168.56
July 1, 1895, balance unexpended		10,680.06
July 1, 1895, outstanding liabilities	$1,000.00	
July 1, 1895, amount covered by uncompleted contracts	2,175.00	
		3,175.00
July 1, 1895, balance available		7,505.06

REPORT OF MR. JOHN ZUG, INSPECTOR.

WILLAPA, WASH., *June 7, 1895.*

CAPTAIN: I have the honor to submit the following report on the improvement of Willapa River and Harbor, Washington, for the fiscal year ending June 30, 1895:

Under your instructions I assumed local charge of these works April 1, 1895.

Messrs. Dickinson & Co., the contractors for the construction of the dike closing Louderback Slough and the repair of the dikes at the head of Mailboat Slough, sublet the work in part to W. R. Gray and in part to C. O. Rude. The construction was carried on under the personal superintendence and inspection of myself at all times.

Louderback Slough Dike.—The construction of this work was begun April 8, 1895, and carried on with little interruption until May 30, when it was completed. The dike was located about 20 feet above the mouth of the slough. The depth of the water along the site of the work is about 8 feet at mean lower low water, except near the banks, where the water is shallower. The piles for this dike were driven from 12 to 20 feet deep in the ground, according to depth of water and character of the bottom, which is composed for the most part of mud and sand. The ends of the dike were carried well up on the banks, the piles being driven at high tide. To provide passage for such boats as have occasion to go in and out of the slough, an opening 30 feet wide was left in the dike. A mattress sill was constructed across this opening of brush fascines woven together, both parallel with and at right angles to the line of the dike and covered with stone. The surface of this sill is 2 feet below the plane of mean lower low water. At either end of the opening dolphins were provided, consisting of six piles driven round a center pile, 6 feet apart, in such a way as to form a hexagon at the base.

These piles were driven 20 feet into the ground, cut off at a uniform height of 16 feet above mean lower low water, and drawn together and fastened with two wraps of half inch wrought-iron chain.

The total length of the dike, including the 30-foot opening, is 228 feet. There are in all 84 piles, including the two dolphins of 7 piles each and 4 guide piles for the construction of the mattress sill. The opening was located a little to the south of the middle of the dike, that section of the dike north of the opening being 120 feet long and the south section 78 feet long. The top of the dike is 10 feet above mean lower low water, which is the general elevation of the banks at either end.

The entire work is provided with a brush mattress, varying from 2 to 3½ feet in thickness, according to depth of water. This mattress is 26 feet wide, extending 10 feet on either side of the dike, and consists of three to five tiers of brush fascines laid crosswise and woven together in both directions with No. 12 annealed iron wire. It is weighted and held in place by a liberal covering of stone.

The dike is lined throughout with 3 by 8 inch timbers, there being seven strips of these on either side in the north section and six strips on either side in the south section of the dike. This timberwork extends from the level of low water to the top of the dike. The outside of the dike is provided with a double wale, bolted to each pile and fastened to the inside timbers also. Each bent of the structure has two 3 by 8 inch cross braces spiked vertically to the piles, with three 8-inch boat spikes in either end.

The space between the two rows of piles is filled with brush fascines, which are weighted thoroughly. This filling extends to the top of the dike. The brush used for this purpose consists mostly of spruce limbs, which make a heavy and solid filling.

The banks at either end of the dike have been covered with brush mattresses well wired and held in place by stakes driven into the ground. This shore protection extends about 10 feet from the dike on the inside, and on the outside has been carried out 35 feet to guard against washing and undermining. The bank has been graded sufficiently to make an even and regular slope. The shore protection is covered with stone to a depth of about 12 inches.

A small, shallow slough enters Louderback Slough on the south side, just above the root of the dike, which closes it entirely. At this point the mattress and shore protection have been made thicker and thoroughly weighted, and it is believed that this small slough will gradually fill up.

Mailboat Slough dikes.—These works consist of one large dike and three smaller dikes which were constructed in 1893. The main dike closes Mailboat Slough proper, and the smaller dikes close three small branches of the same slough. At the time work was resumed on this harbor these dikes were in generally good condition. The filling in all of them had settled from 2 to 6 feet, and a number of the timbers had been damaged or broken by large snags and drift lodging upon the dike at high water.

All missing or broken timbers have been replaced, the filling in the main dike has been brought up to a height of 4 feet above mean lower low water, and that in the smaller dikes has been brought to about the general level of the surrounding tide land, or 6 to 8 feet above mean lower low water. All of these dikes are now in thoroughly good repair.

Shoal No. 1, Willapa River.—The removal of this shoal, which was begun in 1893, was not quite completed at that time, owing to the exhaustion of available funds. The completion of the work is now under contract with Charles O. Rude, but actual operations have not yet commenced. The same method of removal will be pursued as before, and very probably the same plant and apparatus will be used. The material, which is composed for the most part of hard clay, will be blasted loose with No. 1 dynamite (60 per cent nitro-glycerin) and afterwards dredged by means of a clam-shell apparatus, loaded on scows, and deposited well outside of the channel limits in shallow water. As there are but 775 cubic yards of material to be removed, it is probable the work will be completed within two or three months.

I have made a careful survey of this shoal to determine the actual amount of material yet remaining within the limits of the channel.

This survey develops the fact that much of the material along the north edge of the channel has scoured out, while the channel on the south side has filled in considerably with sand and mud. At the time work was suspended in August, 1893, all of the material within the channel limits had been thoroughly broken up by blasting. That remaining along the north edge of the channel, however, was not all removed.

About 300 feet above the upper end of the shoal the river is very narrow and deep, and, forming a curve at the upper end of the shoal, the natural channel is thrown by the force of the current to the north. This is rendered apparent also by the erosion of the river bank on the north side. The eddy formed here accounts in part for the accumulation of material on the south side. It is also partly due to the fact that the material along the south bank is soft and shifts gradually farther into the river, and as there is no current to speak of on that side it remains there. I therefore recommend that the channel lines as established be shifted northward 30 feet. If this is done the quantity of material to be removed to secure a channel 100 feet wide will be considerably lessened, and a permanent channel will be secured.

Removal of North River jam.—This work was begun April 15, 1895, and at this date is a little more than half done. The snags, trees, and miscellaneous drift, composing this jam, form a more compact mass in some places than in others. Many of the logs are loose, but are so hemmed in by the surrounding mass as to preclude their removal until the mass is broken up.

The method of removing the more troublesome snags is as follows:

A wire cable is made fast to the snag to be removed, and is passed through a block fastened to some fixed object on the bank. It passes back, then through another block on the snag itself, and thence to the drum of a hoisting engine of about 10-horsepower. The snag is thus hauled out into the open river and allowed to float

away, or is hauled up on the jam outside the limits of the channel. It frequently happens that when one of these heavy stumps is removed a large part of the surrounding mass is set free, and the logs readily float away. Such snags as the engine can not handle are broken up with dynamite. The greater portion of the material thus far removed has been allowed to float down the river, along which it is well scattered. It is not likely that any great amount of it will pass out of the river before the fall freshets occur.

The contractors for this work have secured a subsidy of about half a million feet of logs, which are worth at current rates $2,250. As this will constitute their profit on the contract, it is obvious that they will be interested in keeping this channel open, when it has once been made, at least until they can market their logs. It is probable also that loggers and settlers will voluntarily do much toward keeping the river clear of obstructions, as they can not otherwise get their timber to the mill. However, if it is possible, it would be wise, I think, to increase the width of this channel to 100 feet, as originally planned. Such a channel would be less likely to become jammed again, and would provide more ample accommodation and aid to navigation.

Materials used and money expended.

1. Construction of Louderback Slough Dike:	
2,832 linear feet piling, at 8½ cents	$240.72
327.21 cords brush, at $2.35	768.95
243.80 tons stone, at 60 cents	146.28
6,944 feet, B. M., lumber, at $11	76.38
800 pounds annealed iron wire at, 3¼ cents	26.00
400 pounds spikes, at 3¼ cents	13.00
66 bolts complete, at 18 cents	11.88
Total cost of dike	1,283.21
2. Repair of Mailboat Slough dikes:	
107.53 cords brush fascines, at $2.35	252.69
102.05 tons stone, at 60 cents	61.23
3,596 feet, B. M., lumber, at $11	28.55
400 pounds spikes, at 3¼ cents	13.00
70 linear feet piling, at 8½ cents	5.95
10 bolts complete, at 18 cents	1.80
Total cost of repairs	363.22

Very respectfully, your obedient servant,

JOHN ZUG, *Inspector.*

Capt. THOMAS W. SYMONS,
Corps of Engineers U. S. A.

COMMERCIAL STATISTICS.

Willapa Harbor is in the collection district of Puget Sound. South Bend is the subport of entry. The nearest light-house is on Toke Point, at the north side of the entrance.

The following returns relative to the commerce of Willapa Harbor and River, are furnished by Deputy Collector A. J. Ferrandini, of the subport of South Bend; they are for the fiscal year ending June 30, 1895:

Arrivals and departures of vessels.

The number of vessels arriving in Willapa Harbor during the year was 216; the number departing was 216. Of this number, 150 were steam vessels and 66 were sail vessels.

Total aggregate tonnage, arrivals and departures, 39,023.

The maximum draft of loaded vessels was 20 feet.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.			IMPORTS.		
	Tons.			*Tons.*	
Lumber (23,000,000 ft., B. M.)	46,000	$207,000	Coal	300	$1,500
Salmon (fresh)	75	3,000	General merchandise	5,000	225,000
Salmon (cases)	850	97,000	Agricultural implements	175	3,500
Salmon (bbls)	10	800			
Clams	125	2,500	Total	5,475	230,000
Oysters	3,000	90,000			
Shingles	2,700	40,500			
Hemlock extract (205 bbls.)	23.7	2,770			
Cranberries	100	15,000			
Spruce stave bolts	3,500	17,000			
Total	56,383.7	475,570			

SUMMARY.

	Tons.	Estimated value.
Total exports	56,383	$475,570
Total imports	5,475	230,000

One more shingle mill has been established on the harbor since date of last report.

No vessels have been built during the year.

The following-named steamers ply between points on Willapa River and Harbor: *Edgar*, *City of Astoria*, *Restless*, and *Favorite;* the amount of freight handled by same has not been ascertained.

T T 15.

IMPROVEMENT OF GRAYS HARBOR AND CHEHALIS RIVER, WASHINGTON.

The first appropriation for this work was made in the river and harbor act approved July 13, 1892.

Description of original condition.—The Chehalis River is the principal tributary of Grays Harbor. From the town of Montesano to the bay the river has generally sufficient water to enable coasting vessels to reach Montesano, but there are four shoals which seriously incommode navigation. At the head of Grays Harbor the waters divide into two channels, one running down the north, and the other down the south side of the bay. There is also a middle channel connecting the north and south channels. In consequence of the division of the waters, shoals exist near the head of the bay, seriously incommoding and limiting navigation.

Plan of improvement.—The plan of improvement adopted is to remove the shoals from the river, so as to give a depth of 16 feet at half tide, by dredging and closing side sloughs and channels, and in the bay to build dikes of piles, brush, and stone to partially close the south channel, leaving a passageway 1,000 feet wide and about 8 feet deep, and wholly close the middle channel with the object of compelling more of the ebbing and flooding waters to flow through the north channel and scour away the existing bar.

The estimated cost of the work proposed is $150,000.

APPROPRIATIONS.

Act of—	
July 13, 1892	$50,000
August 17, 1894	25,000
Total	75,000

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $49,574.91.

Results obtained to June 30, 1894.—The plat in my last annual report shows the location of the dikes built for the improvement of Grays Harbor, as they were actually constructed. The upper dike, from the south shore of the bay to Rennies Island, was completed and the dike crossing the middle channel was partially completed. In this dike all the piles were driven, the mattress laid, and brush and stone added in sufficient quantities to bring the mass up to a low-water level, and, in some places, above.

Work ceased January 19, 1894, funds being exhausted. Just before the completion of the work a survey was made. The results of the completed work are very gratifying, as the water has deepened fully 2 feet over Cow Point Bar, near the head of Rennies Island, and the channels across the bar below Hoquiam have been readjusted and deepened materially.

Amount expended during fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $16,217.88.

Results obtained during the fiscal year ending June 30, 1895.—The work heretofore done in dike building in the bay continues to show beneficial results in a greater depth on the bars in the north channel. It is judged, however, that the looser material of the bars has been removed by the action of the currents, and that the bottom now uncovered on the bars, being of less yielding material, will be but little affected by those currents, and will have to be dredged in order to obtain a greater depth of channel. The channels which, before improvement, carried a ruling depth of from 5 to 6 feet have been increased by the stronger currents induced by the dikes to a depth of from 8 to 11 feet. A greater depth, it is believed, can be maintained by the existing works after the harder material of the bars has been removed by dredging.

The construction of the dike closing the middle channel had induced a deflection of that channel across the bar separating it from the north channel. This threatened to annul the effects desired to be obtained by the closing of the middle channel. The construction of the mattress sill, extending from the end of the middle channel dike extending across the bar to the north channel, has effectually stopped the erosion on that bar.

The effect of the dikes constructed this season on the bars in the Chehalis River below Montesano is not yet apparent. It is believed that the deepening of the channels through them will have to be assisted by dredging and snag removal.

Report of operations.—Under date of September 20, 1894, the work of improving Grays Harbor and Chehalis River was advertised. Bids were opened October 22, 1894, and the following is the abstract of those received:

No.	Name and address of bidder.	Piles, per linear foot.	Lumber, per M feet, B. M.	Bolts, each.	Spikes, per pound.	Brush, per cord.	Wire, per pound.	Stone, per ton.	Edgings, slabs, etc., per cord.	Total.
1	Cameron & Robertson, Portland, Oreg	*Cts.* 8	$12.00	*Cts.* 30	*Cts.* 5	$2.50	*Cts.* 4½	$0.65	.....	$13,604.00
2	Daniel Kern, Portland, Oreg	10	12.00	30	4	2.90	3	58	.....	14,878.00
3	Dickinson & Co., Tacoma, Wash.	8½	11.00	18	3	2.49	3	62	$2.00	13,213.10
4	Pacific Dredging Co., Tacoma, Wash	8	13.00	25	3½	1.80	3½	80	90	11,628.00
5	King & Marrinan, Seattle, Wash.	9	13.00	22	3½	2.22½	3½	85	2.25	13,406.90
6	King & Kittenger, Tacoma, Wash.	10½	14.00	20	3	3.25	3	1.05	2.50	17,930.50

The bid of the Pacific Dredging Company was rejected because of its incompleteness in essential particulars, and the contract awarded to Dickinson & Co., of Tacoma.

The work to be done consisted in making all necessary repairs and additions to the dikes already built; in completing the dike across the middle channel of Grays Harbor; in laying a protecting brush mattress sill across the mud flats to the north of the middle channel dike, and in constructing four small dikes in the Chehalis River at Bents Island, Peels Slough, and Higgings Island.

The actual work was commenced November 21, 1894, the first work undertaken being the construction of the protecting sill to the north of the middle channel dike. The work of completing the middle channel dike was also undertaken and pushed rapidly, and was almost completed when a heavy storm in January seriously injured it, carrying away 32 piles and about 100 cords of brush filling. This was repaired and the work nearly completed when in March another accident happened, carrying away a number of piles in three places from the dike. This was repaired and the dike in the weak places strengthened by connecting the two upright piles and the two inclined brace piles by additional timber cross-ties, 6 by 12 inches, double bolted on at low-water level. The filling of brush was left out above low water for 600 feet in the deepest part of the old channel in order to somewhat relieve the pressure. It is hoped that the structure will stand long enough to cause an accumulation of sand in the channel, which will permit the complete filling of the dike. For further details of operations reference is made to the report of Mr. J. M. Clapp, assistant engineer, herewith.

Recommendations and remarks.—The original plan for the improvement of Grays Harbor and Chehalis River contemplated three things:

1. The construction of dikes in the upper end of the harbor proper, intended to concentrate a greater flow of water in the north channel;
2. The construction of several small dikes in the river below Montesano, shutting off side sloughs, and contracting the width so as to concentrate the flow over the existing bars; and
3. To dredge a channel through the existing bars to a depth of 16 feet at half tide.

Items 1 and 2 have been nearly completed; they will be fully completed within the next month, and any further money which may be appropriated will be available for dredging the shoals of the Chehalis River. It is deemed proper to invite attention to the fact that when the project was formulated in 1890–91 there was no railroad in operation to Grays Harbor. Since then the Northern Pacific has opened its branch line going down the Chehalis River through Montesano to Aberdeen on the north shore and Ocosta on the south shore of the bay. The construction and operation of this railroad materially decreases the navigable importance of the Chehalis River, and it is questionable whether there is at the present time any real necessity for opening up this river to coasting vessels as far as Montesano, dredging through the shoals. Recent work done on the river in removing snags indicates that some, or all, of the shoals consist largely of snags, trees, brush, roots, embedded in refractory clay and sand, etc., which will be difficult to remove. In the years that have elapsed since the examination and survey were made these shoals have changed somewhat also. It is believed that the cost of excavating the projected channel through the shoals of the Chehalis River will be much more than originally estimated on account of the conditions above stated. It is believed that it will be well to reconsider that feature of the project which looks to

dredging a channel through the shoals of the Chehalis River to give coasting vessels access to Montesano. It is far more desirable to improve the entrance to the bay than to thus improve the Chehalis River.

In view of the above I refrain from making an estimate of the amount which can be profitably expended upon the project during the next fiscal year.

Future operations.—The operations of the immediate future will consist in completing the small Chehalis River dikes and in repairing the Grays Harbor dikes where necessary. The mattress sill in the 1,000-foot gap of the main Cow Point dike has given evidences of deterioration by brush coming up, and it is deemed proper to strengthen it by the addition of stone.

Money statement.

July 1, 1894, balance unexpended	$425.09
Amount appropriated by act of August 17, 1894	25,000.00
	25,425.09
June 30, 1895, amount expended during fiscal year	16,217.88
July 1, 1895, balance unexpended	9,207.21
July 1, 1895, amount covered by uncompleted contracts	4,500.00
July 1, 1895, balance available	4,707.21
Amount (estimated) required for completion of existing project. Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867.	75,000.00

REPORT OF MR. J. M. CLAPP, ASSISTANT ENGINEER.

ABERDEEN, WASH., *June 4, 1895.*

CAPTAIN: I have the honor to make the following report of operations on the improvement of Grays Harbor and Chehalis River, Washington, for the fiscal year ending June 30, 1895:

The river and harbor bill of July 13, 1892, carried with it an appropriation of $50,000 to commence this improvement.

Work was commenced under contract on April 1, 1893, and carried on interruptedly until January 20, 1894, when it was suspended owing to a lack of funds; the dike and mattress sill at the head of the channel, aggregating a length of 7,486 feet of dike and shore protection and 1,000 feet of mattress sill, was wholly completed, and 2,300 feet of dike closing the middle channel partly completed.

The total length of dike and mattress sill constructed under this contract was 10,786 feet.

These structures induced a considerable scour across the lower end of Rennies Island in the vicinity of the mouth of the middle channel. This made a modification in the plans necessary. It was consequently decided to construct a protecting sill across the mud flat composing the lower end of Rennies Island, the location selected being such that a settling basin wherein sediment would collect would form and the scour of the lower end of the island be stopped.

The river and harbor act of August 17, 1894, appropriated $25,000 for continuing this improvement. Bids were in consequence called for for continuing the work, as follows:

(1) The repairing of dikes already built at the head of the south channel of Grays Harbor.

(2) The completion of the unfinished dike across the middle channel.

(3) The construction of about 2,000 linear feet of protecting sill across the mud flats to the north of the middle channel dikes; the construction of a dike about 150 feet long, closing the channel to the north of Bents Island in the Chehalis River, and the construction of a dike about 200 feet long at the mouth of a small slough south of the head of Bents Island.

(4) The construction of a dike and mattress sill at the mouth of Peel Slough about 400 feet long, and a dike about 150 feet long, closing the mouth of a small slough directly across the Chehalis River from the mouth of Peel Slough.

(5) The construction of a dike about 160 feet long, closing the mouth of a small slough which joins the Chehalis River near the end of Higgings Island

Acting under your instructions, I proceeded to Hoquiam, Wash., and resumed local charge of the works on this harbor November 7, 1894.

On this date I met Mr. J. Q. Barlow, one of the firm of Dickinson & Co., who was to act in the capacity of superintendent for the contractors.

The result of an inspection of the dikes constructed in 1893 showed them to be in the following condition:

The general condition of the dike built at the head of the south channel, and commonly known as Cow Point Dike, was very good. The brush filling had settled from 1 to 3 feet throughout its whole length of 7,486 feet, and some of the waling and inside lining planks had been broken down and split by heavy drift, which had lodged upon it at different points, particularly along the tangents numbered 2, 3, and 4.

The condition of the middle channel dike, however, was not so good. The settlement of the filling of this dike was greater and averaged about 10 feet for a distance of about 1,800 feet. A break had occurred in the center of this dike, 21 pile bents, covering a length of 126 feet of dike, having been carried away. This break was caused, it is supposed, by very heavy drift being driven against the dike with great force by a strong ebb tide, intensified, no doubt, by heavy swells, which occur at this exposed part of the harbor. Soundings taken at this break showed that the original mattress had been swept out and that where the water was originally but 17 feet deep there was now 33 feet at mean lower low water.

Several of the brace and strut piles were gone and some of the waling and inside lining planks had been broken down, showing that the dike had at some time supported heavy drift—a part of the harvest of the Chehalis River at freshet. No other damage had occurred.

Owing to the unfinished condition in which this dike was left in January, 1894, some damage was expected, and it was a surprise that it was not greater.

Active operations began on November 22, 1894, when the first piles were driven for the construction of the protection sill across the lower end of Rennies Island. The pile driving was continued at each high tide when the weather would permit until December 15, when the last of the 320 piles in this structure was driven.

On November 27 Mr. John Zug relieved me and took local charge of the works as inspector and I returned to Portland for work in the office there.

Protection sill.—The only new work begun in the harbor was the protection sill across the mud flats at the lower end of Rennies Island; it consisted of a mattress of brush 20 feet wide woven around a single row of piles, and was constructed as follows:

Commencing at the north end of the middle channel dike, a single row of piles was driven 16 feet or more into the ground, their tops being 10 feet above the tide flats. The distance between the piles was 10 feet from center to center. This row of piles formed a line running obliquely to the main channel and about at right angles to the ebbing and flooding waters across the flats. At a distance of 2,600 feet from the middle channel dike, the south shore of the main or north channel was reached. Here a deflection in the line of piles was made to the right, following the line up the bank of the main channel a distance of about 600 feet.

In the mattress construction a layer of bundles of brush 20 feet long was laid at right angles to the line of the sill, the middle of each bundle being on the line of the poles. These bundles were securely woven together in three places with No. 12 annealed iron wire. On top of this layer a second layer of bundles of brush was laid longitudinally; this was similarly woven together and fastened to the lower layer with wire. A third layer of bundles was then laid transversely and secured together and to the second layer in the same manner. The mattress was made continuous throughout its entire length of 3,200 feet and securely weighted with stone, which holds it in position. No floats were used in this construction, the work being carried on at low tide.

On each side of the row of piles there was a bolted wale, 3 by 6 inch plank, the upper edge of which was 9 feet 4 inches above the mud flat. Each plank of which this wale was formed overlapped the adjacent plank 4 feet, the junction being at a pile and the overlapping end 2 feet from the center of the pile.

Middle Channel Dike.—Owing to the continued stormy weather the repair and completion of the middle channel dike was necessarily slow and tedious, the contractors experiencing considerable difficulty in getting the material in condition.

On December 19, 1894, the work of pile driving in the break in this dike was begun, and finished on December 22. Eighty-five piles from 40 to 60 feet long were used in the construction of this section, forming 21 4-pile bents. Early in January the mattress, consisting of nine tiers of fascines securely woven together in five places with No. 12 annealed iron wire, was successfully placed and sunk in position with stone.

Then commenced the filling of the dike with brush, but on January 14, 1895, before this had proceeded far, a break occurred in this new section.

The work was inspected and the conditions investigated by Lieutenant Shunk on the 18th. The conclusion arrived at was that the contractors had not exercised due care in bracing the dike and that they were wholly responsible for the loss occasioned by the break. Repairs were again made to this dike in February and March, and the beginning of the end of work was in sight, when again, on March 10, five small breaks in the dike occurred.

Under your instructions I made an examination of the dike and an investigation into the cause of their occurrence and concluded that the damage was entirely due to the failure on the part of the contractors to exercise due precaution against disaster, in that they had neglected to properly cross-tie and brace the structure, and recommended that the contractors be required to repair the damages at their own cost.

On April 1 I resumed personal charge of the works, relieving Mr. Zug, who was transferred to the Willapa Harbor work.

The work of repairing these works was begun on March 29 and was successfully completed on May 1, 1895.

On May 20, the works in the harbor having been completed, the small force that had been left behind to finish up joined the main crew, which had commenced work on the Chehalis River on May 3.

A careful examination of the different channels in the vicinity of the shoals where the improvements on the Chehalis River are to be made showed that it was necessary to construct six short dikes whose length aggregated 1,424 feet.

By authority of the Chief of Engineers, under date of February 5, 1885, the contemplated construction of the dike closing Peel Slough was abandoned and the construction of a tramway dike extending down 670 feet from a point on the right bank of the Chehalis River above the mouth of Peel Slough was embodied in the project, this new dike to extend diagonally across the north or right channel and concentrate the current in the south channel through the shoal at that place. All the piles for the six dikes have been driven and the two dikes in the vicinity of the mouth of Peel Slough about completed. It is expected that all of the dikes to be constructed in the Chehalis River will have been completed by July 1, 1895. The material into which the piles for the upriver dikes have been driven is very hard and consists of compact gravel, the stones composing it being about the size of a hen's egg and flintlike in hardness. One hundred and two blows of a 2,000-pound hammer on a pile were required to cause it to penetrate 10 feet. More blows would have punished the pile beyond its strength and would probably have caused a buckling of the fibers.

Surveys.—In September and October, 1894, surveys were made of the entrance to Grays Harbor and of the inner harbor in the vicinity of the dikes built in 1893.

The disclosures made by the survey of the inner harbor are most gratifying and demonstrate the success of the project of dike building in the harbor.

At the shoal at the junction of the north and middle channels the depth at low tide has increased from 6 feet to 13½ feet; at Hoquiam Shoal it has increased from 6 feet to 11 feet, and at Cow Point Bar from 5 feet to 8 feet.

Observations.—Since the construction of the protection sill across the lower end of Rennies Island, where scour had been continually going on since 1893, grass has now started to grow over the whole flat. Sediment is piling upon the protection sill and on either side of it, forming little hummocks, some of which are a foot above the level of the flat.

Since the completion of the middle channel dike and the refilling of the Cow Point Dike the velocity of both the ebb and flood tide in the north channel has very greatly increased. In the basin of the middle channel, the water is practically dead and clear, while the line of division between it and the north channel at the low state of the ebb tide is plainly marked by the muddier appearance of the water of the north channel. Tugboats and steamers, which formerly had to wait until nearly full tide to cross Cow Point Bar, rarely have to wait now at all, but can cross it with their loaded tows on the flood tide a couple of hours after the turn of the tide.

The Hoquiam Shoal and Cow Point Bar have not appreciably scoured out since September, 1893. I am of the opinion that the soft sedimentary deposit has long since scoured away, leaving now a shoal of very tough clay, which can not be removed except by dredging.

Owing to the refractory nature of the shoals in the Chehalis River I am inclined to think that if the project is to be carried out they will have to be removed by dredging, trusting only to the dikes constructed in their vicinity to keep them open. I am further of the opinion that a 16-foot channel to Montesano at a half stage of the tide will be a difficult work to accomplish. With what little data I now have I

believe the bottom of the river above Cosmopolis to be a network of snags, which will prove a menace to navigation for all time. If this channel is to be accomplished I believe some extensive snagging operations will have to be carried on.

With the completion of the dikes now under contract will end the improvement in accordance with the approved project as far as the dike building is concerned, and I respectfully recommend that before the project is extended more data regarding the condition and character of the bottom of the river be gathered; that a survey be made of the upper portion of the river, and that borings be made at the shoals to determine whether they are composed of gravel or cement gravel, as on this classification depends largely the cost of their removal.

The commercial statistics of this harbor, I am informed, have been in former years largely guessed at. Accompanying this report are the statistics of imports and exports for the twelve months ending May 31, 1895, the result of personal searches and inquiries.

In conclusion I beg to speak of the disposition of the contractors. It has been my pleasure to be associated with Mr. J. Q. Barlow, junior member of the firm of Dickinson & Co., who has acted in the capacity of superintendent of construction for his firm. He is an able engineer and one to whom the statement of a fact is sufficient; its argument unnecessary. It appears to be the pride of this firm to do their work in a thorough and workmanlike manner, employing none but experienced and capable men, every one of whom has received compensation of not less than 25 cents per hour, their argument being that cheap labor is expensive labor.

The following table shows the amount of material received and used in the construction of the dikes in Grays Harbor and Chehalis River from November 22, 1894, to May 31, 1895:

28,282 linear feet piling, at 8½ cents	$2,403.97
3,130.5 cords fascines, at $2.49	7,794.94
5,123.5 tons stone, at 62 cents	3,176.57
2,890 pounds wire, at 3 cents	86.70
90,741 feet, B. M., lumber, at $11	998.15
8,000 pounds spikes, at 3 cents	240.00
876 bolts, at 18 cents	157.68
Total	14,858.01

The following shows the length of the structures that will have been built by June 30, 1895:

	Linear feet.
Cow Point Dike	7,486
Cow Point Dike mattress sill	1,000
Middle channel dike	2,300
Protection sill	3,200
Chehalis River Dike—	
No. 1	250
No. 2	125
No. 3	150
No. 4	670
No. 5	129
No. 6	100
Total length all structures	15,410

The contractors during the season's work made subcontracts for material as follows: Brush fascines delivered on scow, $1.50 per cord; piles delivered, 4 cents per linear foot; rock delivered on scow, 30 cents per ton.

The contractors furnished the scows and paid all towing bills.

Respectfully submitted.

Your obedient servant,

J. M. CLAPP,
Assistant Engineer.

Capt. THOMAS W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Grays Harbor is in the collection district of Puget Sound. Aberdeen is a subport of entry. The nearest light-house is at Toke Point, Cape Shoalwater, 14½ miles south of the entrance. The sight for a new light-house has been selected on Peter-

sons Point, at south entrance to the harbor, but the work of building same has not yet commenced.

The following returns relative to the commerce of Grays Harbor and Chehalis River for the fiscal year ending June 30, 1895, have been collected by Mr. J. M. Clapp, assistant engineer, in local charge of works at Grays Harbor, and by Mr. W. B. Mack, secretary Aberdeen Chamber of Commerce:

Arrivals and departures of vessels.

Steam and sail vessels.	Number.	Aggregate tonnage.
Steamers arrived, coastwise	48	11,832
Sail vessels arrived, coastwise	161	44,308
Sail vessels arrived, foreign	8	3,093
Steamers departed, coastwise	48	11,832
Sail vessels departed, coastwise	163	43,234
Sail vessels departed, foreign bound	7	3,340
Total	435	117,639

Of the clearances 209 carried lumber.

Maximum draft of loaded vessels was 17 feet.

The only vessel built during the year was a small launch of 20 tons capacity and propelled by a gasoline engine, built at Hoquiam. The steamers *Point Loma* and *Del Norte* make regular semimonthly trips between Grays Harbor and San Francisco, carrying freight and passengers. The former draws 15 feet, loaded, and the latter 13½ feet.

Exports and imports.

[Vessel shipments.]

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.	*Tons.*		IMPORTS.	*Tons.*	
Lumber (76,291,000 ft., B. M.)	152,582	$610,328	General merchandise	1,640	$81,473
Shingles	960	13,800	Cans for salmon cannery	32	3,200
Piles (1,800)	900	3,600	Mill machinery	180	9,000
Spars (11)	11	1,100	Hardware and oils	200	20,000
Telegraph poles (40)	20	250	Coal	100	500
Hides	100	6,000	Pig, sheet, and bar iron	200	8,000
Fresh salmon	1	40	Miscellaneous	300	30,000
Canned salmon	153	17,595			
Salt salmon	5	300	Total	2,852	172,173
Stave bolts	400	1,000			
Basket stock	1,740	22,000			
Miscellaneous	20	400			
Total	156,892	676,418			

SUMMARY.

	Tons.	Estimated value.
Total exports by water	156,892	$676,418
Total imports by water	2,852	172,173

In addition to the exports by water above tabulated, the Northern Pacific Railroad shipments from Grays Harbor points during the fiscal year, consisting of lumber, shingles, fish, butter, farm produce, etc., amounted to 27,555 tons, being an estimated value of $597,878. This does not include railroad shipments of specie from towns on the harbor, amounting to upward of $110,000 during the year.

Chehalis River traffic.

Steamers.	Freight carried.	Passengers carried.	Service.
	Tons.		
Thistle	156	624	Hoquiam and Oyehut.
Josie Burrows	3,998	13,162	Aberdeen Ferry and local freighting
Tillie			
Toiwo			
Montesano	200	4,300	General jobbing between harbor and river points.
Alert			
Jessie			
Nilmo			
Total	4,354	18,086	

Estimated value of this river freight is $233,691

The number of passengers arriving by ocean steamers was 101. The number of passengers departing by ocean steamers was 91.

New industries.—The west sawmill has been taken down, rebuilt, and fitted with new machinery for increasing its capacity. A new creamery is being built at Montesano. Eastern lumber shipments have assumed large proportions and are constantly increasing. The foreign lumber trade is hindered by inability of deep-draft ships to clear or cross the bar at entrance to Grays Harbor.

T T 16.

IMPROVEMENT OF CHEHALIS RIVER, WASHINGTON.

Description of original condition.—The portion of the Chehalis River that it is possible to navigate is about 90 miles in length, from Claquato to its mouth. This may well be considered in three sections:

1. The tidal section, from the mouth to Montesano, a distance of 15 miles. In this portion there is about 18 feet of water at high tide, and coasting vessels traverse it.

2. From Montesano to Elma, 16 miles, the river is slightly affected by the tides, and has in general sufficient depth of water for light-draft boats. But navigation is obstructed by logs and fallen trees, and in summer by a scarcity of water on the bars.

3. Above Elma the river is practically blockaded by snags and a general lack of water. The river is a succession of shoals and pools. On many of the shoals the depth is reported to be only from 6 to 12 inches.

Plan of improvement.—The plan of improvement contemplates the removal of snags, overhanging trees, jams, drift heaps, shoals, and other obstructions to navigation which may from time to time accumulate in the portion of the river regularly used by boats.

The cost of the work is indefinite.

APPROPRIATIONS.

Act of—	
August 2, 1882	$3,000
July 5, 1884	2,500
August 5, 1886	2,500
August 11, 1888	2,000
September 19, 1890	3,000
Total	13,000

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $12,503.16.

Results obtained to June 30, 1894.—The river from Montesano to its mouth was kept open and free from troublesome snags.

Amount expended during the fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $496.84.

Results obtained to June 30, 1895.—The work done on the river was to clear it of the most troublesome snags and was of great benefit to navigation. The results can, however, only be considered as temporary.

Report of operations.—During October, 1894, preparations were made for doing some work on the river with the very limited amount of money available. A steamer, the *Montesano*, with full crew and engine, rope, blocks, and all supplies needed for carrying on snagging operations, was engaged for $30 per day. The work commenced and was carried on for two days, October 23 and 24, when a sudden freshet in the river interrupted it, and all operations ceased. During these two days a number of troublesome snags were removed. This work was resumed May 22, 1895, and operations in snagging were carried on for six days. The report of Mr. J. M. Clapp, which is herewith, gives report of operations in detail.

Recommendations and remarks.—The Chehalis River is a highway of commerce which is so situated that it must necessarily become from time to time obstructed by snags. To keep it open and remove dangers to navigation it is necessary to go over it once a year and remove these obstructions. Some years these amount to but little, but if violent freshets have prevailed dangerous snags may accumulate in great numbers.

There has been no appropriation for the Chehalis River since 1890, when $3,000 was appropriated.

An appropriation of $3,000 is recommended for this work for the fiscal year ending June 30, 1897.

Future operations.—There can be no further work on this river until another appropriation is available.

Money statement.

July 1, 1894, balance unexpended	$496.84
June 30, 1895, amount expended during fiscal year	496.84
Amount (estimated) required for completion of existing project.	(*)
Amount that can be profitably expended in fiscal year ending June 30, 1897	3,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. J. M. CLAPP, ASSISTANT ENGINEER.

ABERDEEN, WASH., *June 8, 1895.*

CAPTAIN: I have the honor to make the following report on improving Chehalis River, Washington, for the fiscal year ending June 30, 1895:

After each freshet troublesome snags, trees, and stumps are found lodged at different points in the river, which cause the navigation of the river to be difficult, in some places dangerous, and in other parts impossible.

In September and October, 1893, the river between Montesano and the mouth was cleared of troublesome snags, but the succeeding freshet in this river brought down a great number of snags and trees, some of which lodged in the channel at different points and again interfered with safe navigation.

In September, 1894, acting under your instructions, I made an examination of the river from its mouth as far as Montesano, finding at that time several overhanging

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* Indefinite.

trees and about forty troublesome snags. The latter were particularly bad at three points: The bend just below Montesano, commonly known as Tannery Bend, in the vicinity of the Chehalis Boom, and in the vicinity of Sand Island.

The United States owns no snag boat or steamer on Grays Harbor and Chehalis River.

In September, 1894, public notices were posted in conspicuous places in the different towns situated along the river asking for proposals for the services of a steamer suitable for carrying on snagging operations. After twelve days from the time of posting these notices two proposals were received, one from the Grays Harbor Commercial Company, of Cosmopolis, Wash., offering the services of their steamer *Montesano*, fully rigged, with steam hoisting apparatus, etc., and a crew of six men, for the sum of $30 per day; the other from Capt. E. Erickson, managing owner of the steamer *Tillie*, of Hoquiam, Wash., offering the services of his steamer, rigged with lines, blocks, etc., a hand windlass for hoisting, and a crew of four men, for the sum of $22.50 per day.

The proposal of the steamer *Montesano* was accepted, and on October 17, 1894, Mr. John Zug, who was assisting me with the survey of the entrance to Grays Harbor, was relieved and instructed to oversee the operations of snagging and to limit his work to ten days, the available funds not permitting of a longer period being spent.

On the day that work began a freshet in the river occurred, and after one day's work, removing such snags as could then be handled, it was abandoned for the season, it being impossible to do good work.

Work was resumed on May 22, 1895, the steamer *Montesano* being again used.

The low run-outs of the tide, from 1 to 2 feet below zero, permitted of a close examination of the bottom of the river being made.

At the low stage of the tide each day the work was carried on at the bend just below Montesano, where an island shoal composed of snags, roots, tree tops, and sediment had formed, dividing the channel at this point and making it dangerous to navigate. During the high stages of the tide work was carried on at different points on the river removing the snags in the channel whose tops floated with the tide.

Effective work was done during the six days the steamer was employed. Six overhanging trees, averaging from 3½ to 5 feet through at the butt, were cut down, 17 floating snags removed from the channel, and 23 snags, chunks, stumps, etc., removed from the bed of the river in the bend just below Montesano.

A slight rise in the river and the exhaustion of the appropriation for this work forced a suspension May 27, 1895.

The method employed for the removal of these snags was the same as that used last year. A chain made of 1-inch iron, attached to a 5-inch line by means of an iron hook, was slipped over the end of the snag and drawn taut; the line was then passed through a snatch block, which was made fast to some stationary object on shore, the end being made fast to the bitts at the bow of the steamer, and by means of the power exerted by the propelling power of the steamer the snag was hauled well up on the bank.

One hundred pounds of No. 2 giant powder, made into two cartridges and fastened to a large root, a part of the island shoal in the bend below Montesano, was exploded by means of a long fuse and did effective work. It was impossible for the steamer to dislodge this root until after the explosion, which removed a great deal of the accumulated sediment, brush, etc., which had gathered round it.

During the past twelve months the upper portion of the river above Montesano, which during the summer is a succession of pools dammed by shallow bars, has not been navigated by any craft other than rowboats, the presence of overhanging trees along the banks and sunken snags in the channel making it dangerous for a steamer to navigate this stretch of the river when the water has risen during the freshet season.

Steamers make daily trips between Montesano and the mouth of the river, an occasional trip to a warehouse situated about 6 miles above Montesano, and rarely a trip as far as Elma.

The heavy and troublesome drift which comes down the Chehalis River and its tributaries during the freshet season consists of large spruce, cottonwood, and hemlock trees, having their roots attached to them, and which hang up at the shoal places in the upper river or lodge against the dikes built in the harbor at the mouth of the river. They are the overhanging trees, which, becoming undermined by the action of the currents year after year, tumble into the river and are carried downstream.

I am of the opinion that were these overhanging trees cut down they would float unobstructed down the river to the sea and greatly lessen the obstruction to navigation they occasion each year, and insure less danger and damage to the dikes built in the inner Grays Harbor at the mouth of the river.

I am of the opinion that between Montesano and Elma considerable heavy drift has lodged, which with each succeding freshet will be carried downstream, and being waterlogged, will cause trouble in the river below. In view of this, I believe

active operations should be carried on between Montesano and Elma, in so far as the removal of heavy drift is concerned.

I respectfully recommend that these operations be carried on at summer season, when the river is at a low stage, and that the drift be cut up into small lengths and allowed to float away with the succeeding freshet.

Very respectfully, your obedient servant,

J. M. CLAPP, *Assistant Engineer.*

Capt. THOMAS W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The commercial statistics for the Chehalis River are given among the statistics for Grays Harbor and Chehalis River.

T T 17.

IMPROVEMENT OF HARBOR AT OLYMPIA, WASHINGTON.

The first appropriation for this work was made in the river and harbor act approved July 13, 1892.

Description of original condition.—Olympia is situated at the head of Budd Inlet. The upper end of this inlet is badly shoaled. The shoals extend from the heart of the city at Fourth Street Bridge for a distance of 8,750 feet, to a depth of 12 feet at low water in Budd Inlet. These shoals necessitated the building of long wharves out to deep water, the maintenance of which, due to the ravages of the teredo, was very expensive. The alternative of this, i. e., boats coming and going only at high tide, caused great inconvenience.

Plan of improvement.—It is proposed by the plan of improvement adopted to dredge a channel 250 feet wide and 12 feet deep at the mean of the lower low waters from the vicinity of the Fourth Street Bridge to deep water in Budd Inlet.

The estimated cost of the work was $275,000.

APPROPRIATIONS.

Act of—	
July 13, 1892	$35,000
August 17, 1894	40,000
Total	75,000

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $34,982.73.

Results obtained to June 30, 1894.—A channel 6 feet deep at low water was dredged from Fourth Street Bridge to deep water in Budd Inlet. This channel as dredged is 7,645 feet long, and generally 125 feet wide. For 1,500 feet at the upper or city end of the channel the width was reduced to 105 feet, in order to keep the amount of dredging within the limit allowed by the appropriation. The Capitol Waterway was excavated to the width of 90 feet as far as the bridge.

Amount expended during fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $38,953.64.

Results obtained to June 30, 1895.—A channel 200 feet wide and 6 feet deep at low water has been completed for the entire distance from deep water in Budd Inlet to the southern limits of the main waterway at the south line of Second street extended. At this southern limit

the dredged waterway has been enlarged into a basin for the convenience of boats in turning. This basin is 800 feet long, has an average width of 450 feet, and an extreme width of 500 feet.

Report of operations.—The work of dredging in Oylmpia Harbor was advertised for in September, 1894. Bids were opened on October 1, 1894, and the following is an abstract of the bids received:

No.	Name and address of bidder.	Per cubic yard	Total.
		Cents.	
1	San Francisco Bridge Co., Seattle, Wash	$16\frac{4}{10}$	32,800
2	Pacific Dredging Co., Tacoma, Wash	16	32,000
3	John H. Estes & Co., Tacoma, Wash	$12\frac{1}{2}$	25,000
4	Bowers Dredging Co., Portland, Oreg	16	32,000

For reasons set forth in my report of October 2, 1894, it was recommended that the bid of John H. Estes & Co., of Tacoma, be rejected, and that the work be awarded to the Bowers Dredging Company. The recommendation was approved, and October 18, 1894, the contract was made with the Bowers Dredging Company.

The actual work of dredging commenced November 4, 1894, and continued until February 28, 1895.

During this time the contractors excavated and were paid for 224,071.17 cubic yards. As, however, the cut was invariably made deeper and wider than that called for by their contract, this amount was in reality considerably exceeded.

Nearly all the material excavated from the basin was used in filling in and making a solid causeway along the line of the Fourth Street Bridge. This was done under an arrangement with the city of Olympia, which went to the expense of supplying the requisite bulkheads along both sides of the bridge, and at the Capitol and Des Chutes waterways.

By this combination, great good was accomplished to the city by the utilization of the material which would have otherwise been wasted.

The work throughout was under the charge of Mr. John R. Savage, assistant engineer.

The excavation of the channel out to deep water, and the filling up of Fourth street, has developed very strong tidal currents through the Capitol Waterway, which, at the bridge, is narrow, obstructed, and encroached upon.

It is desired, by parties owning docks along the Capitol Waterway, that some measures be taken to throw more of the ebbing and flooding waters through the Des Chutes Waterway, which lies to the west of the Capitol Waterway, and is much wider.

I am inclined to think, however, that natural causes will bring this about. If it does not, and the currents continue to be swift and dangerous, it may be necessary to take measures to deflect them, as suggested. This can be considered when the next appropriation for the work becomes available.

Recommendations and remarks.—The project for the work at Olympia calls for a channel 250 feet wide and 12 feet deep at low water, from the vicinity of Fourth Street Bridge to deep water in Budd Inlet.

The channel so far has been made 200 feet wide and 6 feet deep at low water. Six feet depth is ample accommodation for all boats now running to Olympia. When the channel is completed to the full width of 250 feet, the main and immediate good to Olympia will have been accomplished, as it will enable boats of the class now running to

the city to safely reach the wharves at all hours and at all stages of the tide and condition of wind and weather.

The further deepening of the channel will permit the size and draft of the boats running to the city to be increased.

The legislature of the last winter made an appropriation for a new capitol building, to cost about $2,000,000. This insures the retention of the capital of the State at Olympia, and to this extent insures the future importance of the city.

The completion of the channel and basin to their full width and to a depth of 6 feet will cost about $25,000.

Any amount appropriated further than this will be applicable to deepening the channel and basin.

It is estimated that $100,000 can be profitably expended upon the project during the next fiscal year.

Future operations.—With any money that may become available in the future, the first thing to be done would be to widen the channel and basin to the full limit covered by the project and to 6 feet depth. After this the work would be largely dependent upon the amount of money available.

Money statement.

July 1, 1894, balance unexpended	$17.27
Amount appropriated by act of August 17, 1894	40,000.00
	40,017.27
June 30, 1895, amount expended during fiscal year	38,953.64
July 1, 1895, balance unexpended	1,063.63
Amount (estimated) required for completion of existing project	200,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	100,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

REPORT OF MR. JOHN R. SAVAGE, ASSISTANT ENGINEER.

MAY 2, 1895.

CAPTAIN: I have the honor to submit the following report of operations in improving Olympia Harbor, Washington, during the fiscal year ending June 30, 1895.

The proposed work under the appropriation of August 17, 1894, was the partial completion of the dredged basin and the widening of the channel formerly dredged to a width of 200 feet at the bottom, all to be dredged to the depth of 6 feet at extreme low water. A contract to do this dredging at the rate of 16 cents per cubic yard was entered into October 18, 1894, with the Bowers Dredging Company, of Portland, Oreg., and to prepare for and to take charge of this work I left Portland, October 29, arriving in Olympia the same day.

The channel dredged under the appropriation of July 13, 1892, was considerably wider than the lines of dredging called for, and, in computing the amount of this year's dredging, the west bank of the channel was considered to be 5 feet to the west of the west lines of the dredged channel of 1893, with side slopes of 1 on 1. An agreement to this effect was entered into with Mr. A. L. Horner, the superintendent of the Bowers Dredging Company.

As the bottom of Olympia Harbor is very even and regular, it was decided to make the necessary surveys of the bottom by the use of two sextants, observing simultaneously to three known points, to locate the point of observation. The line of swinging piles used by the dredger in 1893 furnished the necessary objects to sight to, and in order to locate these piles a line was run on the track of the Port Townsend Southern Railway for about 5,850 feet of its length, and from the various points of this line angles were carefully turned to the swinging piles. This line along the railway track was tied in with the streets of Olympia and with the other lines on the east of the basin to be dredged. The latitudes and departures of the points on the various lines were computed and the coordinates also of the swinging piles; this by means of the observed angles. The zero of these latitudes and departures is a

point on the center line of Washington street, Olympia (the center line being furnished by the city engineer), 25 feet north of the south line of Fourth street, and the center line of Washington street is taken as the meridian of these coordinates. I have been informed that when the Olympia Harbor lines were laid down it was originally intended to have the east side of the main waterway parallel to the meridian line assumed above, or, in other words, parallel to the north and south streets of Olympia, but as an error of about five minutes crept in, the outer end of the harbor line is slightly farther west than originally intended.

Parts of the survey of 1893 were used in connection with the above-mentioned survey to develop the contour of the bottom, of which a plat was made, cross sections taken at distances of 10 and 20 feet apart and platted, from which the sectional areas of the cutting required were computed. The total volume of dredging required was ascertained to be 224,071.17 cubic yards, which amount includes the 1,722.09 cubic yards excavated from in front of Percival's Dock, where the old dredged channel had shoaled somewhat. This was the only place found to have shoaled any, and was undoubtedly caused by the cutting of a portion of the bank above and around the Fourth Street Drawbridge on the extreme "long run outs." The material thus carried away settled in the comparatively dead water opposite Percival's Dock and caused the high spot in question.

The dredger arrived in Olympia October 31, 1894, and started in November 3, 1894, on the excavation of the basin (amounting in all to 107,674 cubic yards). By a provision of the contract the Bowers Dredging Company were required to place the excavated material on the line of the Fourth Street Trestle for use in filling the tide flats, the city of Olympia agreeing to retain and take care of the excavated material. In this way the material that would otherwise have been wasted was made to be of great service in filling the streets and some of the adjacent lots. On the east side of the Capitol Waterway a brush bulkhead was built by the city on the west line of Water street, extending from the south side of Third street to a point about 125 feet south of the south side of Fourth street, and thence carried east by the property owners to the high land, the tide flats thus inclosed and filled amounting to a little over 2 acres. This bulkhead was formed of brush fascines about 20 feet or more in length, laid transversely with the line of the bulkhead, and with butts out toward the channel, and in courses of about 2 feet in thickness. On top of and about 2 feet in from the edge of each course was laid a string piece of round timber about 8 or 10 inches through, which was tied back by another piece of about the same size, at right angles to the first and spiked to piles inside of the bulkhead and of the fill.

The next course of fascines, or the bottom part of it, was laid abutting against the string piece, and in this way any movement outward was prevented. The face of the bulkhead was usually built with a slope or batture of about one on one-half, and the height was, on an average, about 13 feet.

The filling east of the Capitol Waterway was completed November 19, 1894, whereupon the discharge pipe was carried on the Fourth Street Trestle to the west of the Deschutes Waterway, and the filling of that part of Fourth street started. On each side of this waterway the end of the fill was retained by a bulkhead or crib work of timber. The pieces forming this crib were usually 10 by 12 inch timbers carefully jointed and framed before being put in place. The different layers of timber were all driftbolted together and each course tied back by other timbers extending to piles inside of the fill; in this way the whole structure was perfectly free to settle. A brush mattress about 30 feet in width extends under these cribs and along their faces.

At the sides of the street the filling was retained by planking spiked to the piles forming the roadway or the support thereto. The planking would extend to a height of 4 or 5 feet on one row of piles and then would step back till the next row was reached, and in this series of steps the fill was carried to the caps of the trestle.

To fill the portion of Fourth street west of the Deschutes Waterway the excavated material had to be carried a distance of about 2,000 feet, and progress was rather slow on this account, as considerable extra power was required in forcing the dredged material to such a distance, as the pipes clogged and clear water had to be pumped about half the time to keep the material on the move.

At the west side of the Capitol Waterway, the end of the fill was retained and held in place by a brush bulkhead of similar construction to the one already described. A brush mattress about 3 feet in thickness underlies the outer edge of this bulkhead and extends about 40 or 50 feet out from the bulkhead toward the channel, and is well loaded with rock.

In filling Fourth street and the various properties adjacent and adjoining, about 120,000 cubic yards of material was used, but as the contractors dug both wider and deeper than required, the dredged basin had not been completed when Fourth street was fully filled, and consequently about 20,000 or 30,000 cubic yards was wasted behind or to the east of Percival's Dock.

Beside the partial completion of the basin, the channel width was extended 90 feet for a space about 600 feet in length, and increased 70 feet in width for a distance of about 5,720 feet, thus making all of the channel to the north of the basin of a uniform width at the bottom of 200 feet. The excavated material from this widening of the channel was deposited along the old Long Wharf or in line with it for the portion of the channel to the north of the end of the wharf.

The dredged depth called for was the same as that of the old dredged channel, viz, 6 feet at extreme low water, but the depth of the channel when completed was about 1½ or 2 feet greater on an average than the depth called for, this extra excavation being a measure of safety on the part of the contractors.

As in 1893, the excavated material was found to consist principally of sand with a top covering of about 2 feet of mud. Here and there through the sand would be found a streak of shells, frequently cemented together, which made a very hard material.

The following table shows the rate of progress during the four months the contractors were at work:

Month.	Actual days of work.	Excavation.
		Cubic yards.
November, 1894	15	40,000
December, 1894	26	40,000
January, 1895	27	62,700
February, 1895	24	81,371.17
Total	92	224,071.17

From the above, it is seen that the excavation per working day was 2,435.5 cubic yards, or, in round numbers, about 2,500 cubic yards per day.

The tide gauge on Percival's Dock, with its zero 5.1 feet above extreme low water, was replaced by a new tide staff divided into feet and tenths, with the divisions cut into the wood, set with its zero at the datum plane.

The present dredged channel has a bottom width of 200 feet, with a basin at its southern end varying in width from 500 to 200 feet. For most of its 800 feet of length, however, the dredged basin has a width of over 400 feet. All the dredging as stated above was to the depth of 6 feet at extreme low water.

The project for the improvement of Olympia Harbor contemplates a dredged channel 250 feet in width, extending from deep water on the north to the south side of Second street prolonged, and thence by the Capitol Waterway to the Fourth Street Bridge. This channel broadens out into a basin 500 feet wide at its southern end (on the line of the south side of Second street), and 1,600 feet north thereof narrows to 250 feet. This is all to be dredged to a depth of 12 feet at extreme low water.

To complete this project to the present depth of 6 feet at extreme low water will require the following amount of excavation:

	Cubic yards.
To complete basin	56,000
To complete project north of basin	65,000
Total	121,000

To complete the total project will require the following amount of dredging:

	Cubic yards.
To complete project to 6 feet depth	121,000
To complete basin to 12 feet depth	141,000
To complete Capitol Waterway to 12 feet depth	13,000
To complete Channel N of basin to 12 feet depth	343,000
Total	618,000

The next appropriation, I believe, could be well expended in completing the project to the depth of 6 feet at extreme low water, and any money that might remain could be well expended in deepening the dredged basin.

The present dredged depth is sufficient to accommodate all the present interests of navigation, which is confined to light-draft boats and steamers.

In January, 1895, a survey was made of a portion of Olympia Harbor, south of the Fourth Street Bridge, to determine the cost and method of diverting the channel from the upper harbor from the Capitol to the Deschutes Waterway. On extreme run outs the velocity of the current in the Capitol Waterway causes considerable

OLYMPIA HARBOR,
WASHINGTON

SHOWING PRESENT AND PROJECTED IMPROVEMENT

Scale

ft. 400 300 200 100 0 400 800 1200 1600 2000 ft.

PLAN OF IMPROVEMENT

To dredge a channel 250 ft. wide and 12 ft deep at low water from the vicinity of the Fourth Street Bridge to deep water in Budds Inlet.
Also to dredge out a basin at the upper or southern end of the channel 1600 ft. long, with a maximum breadth of 500 feet.

APPROPRIATIONS

	$
Act of July 13th 1892	35,000.
Act of Aug. 17th 1894	40,000.
	$ 75,000.

REFERENCE

Soundings are expressed in feet and indicate the depth at the mean of a few selected lowest low waters (U.S.C.&G. Survey datum)
Minus soundings indicate heights above datum.
Dredged channel (depth 6 ft below datum) indicated thus
Outline of Project is indicated thus
Low water line and edges of old channels indicated thus
High water line indicated thus: H.W.
Established Harbor lines "
Mean of all observed high waters (83) above plane of reference, 17.72 ft.
Dredging done under the Appropriation of July 13. 1892, shown thus:

Sent with Annual Report, 1895

H. M. Chittenden
Captain, Corps of Engineers.

Drawn by A. Downing.
Eng 54 1

scouring, and this material in suspension is usually deposited in the dredged channel below; besides this the velocity of the currents is liable to damage wharves, etc., on this waterway. If this water were to run off by way of the Deschutes Waterway, no damage would be done to the dredged channel, and the velocity of the current would not be nearly so great, as there is no dredged channel there to give the water any great amount of fall. I believe the diversion of this upper channel to be a necessary part of the improvement of Olympia Harbor, the cost of which should be included in the estimate for completing the project, and the work done as soon as funds will permit.

Very respectfully, your obedient servant,

J. R. SAVAGE, *Assistant Engineer.*

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Olympia Harbor is in the collection district of Puget Sound. Tacoma is the port of entry.

The following returns relative to the commerce of Olympia Harbor for the fiscal year ending June 30, 1895, were furnished by Mr. George B. Lane, secretary to the Olympia Board of Trade.

Shipping.—There are two daily lines of steamers running between Olympia and Seattle; two daily steamers to Shelton and one to Tacoma, all making round trips. The amount of freight handled by the Olympia-Seattle line averages 10 tons daily. Average number of passengers carried daily by these combined lines is 75.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.	*Tons.*		IMPORTS.	*Tons.*	
Logs (2,000,000 feet, B. M.)	5,000	$10,000	General merchandise and machinery	2,500	$125,000
Lumber (1,100,000 feet, B. M.)	2,200	11,000	Coal	1,200	5,000
Sash, doors, etc	(*)	4,000	Logs (1,000,000 feet, B. M.)	2,000	5,000
Oysters (12,000 sacks)	750	30,000	Agricultural implements	1,000	3,000
Clams (10,000 sacks)	450	8,000			
Mussels (2,200 sacks)	110	3,500			
Cord wood (4,000 cords)	10,250	8,000	Total	5,800	138,000
Fruit and vegetables	(*)	20,000			
Hay	400	3,200			
Ice	100	1,000			
Grain	50	1,200			
Ironwork	5	500			
Wooden water pipe	10	1,000			
Total	19,325	101,400			

*Unknown.

SUMMARY.

	Tons.	Value.
Total exports	19,325	$101,400
Total imports	5,800	138,000

New industries.—The Olympia Door and Lumber Company's new mill on the east side of the harbor began operating about two months ago, and are now manufacturing about 25,000 feet of lumber daily.

The steamers are doing much more business than last year, probably on account of the Northern Pacific Railroad discontinuing their train service through Olympia. This railroad runs only one train daily from Seattle to Olympia and return to Seattle.

The steamers *Aberdeen* and *Multnomah* run daily to Seattle. The steamer *Skagit Chief* runs daily to Tacoma. The steamers *Doctor* and *City of Shelton* run daily to Shelton and Kamilche, and the *Estella* has a mail route round the islands twice a week.

T T 18.

IMPROVEMENT OF WATERWAY CONNECTING PUGET SOUND WITH LAKES UNION AND WASHINGTON.

This is a new work, the first appropriation for it having been made in the river and harbor bill of August 17, 1894.

The river and harbor bill of September 19, 1890, contained an item directing the appointment of a Board of three officers of the Corps of Engineers, upon whom should devolve the duty of selecting and surveying the most feasible location, and of estimating the expense of constructing a ship canal to connect the waters of Lakes Union, Washington, and Samamish with Puget Sound, and appropriating $10,000 for the necessary expenses.

The Board thus appointed consisted of Col. G. H. Mendell, Maj. T. H. Handbury, and Capt. T. W. Symons. Their report is contained in House Ex. Doc. No. 40, Fifty-second Congress, first session, and also in annual Report of Chief of Engineers for 1892, page 2762 et seq.

Description of original condition.—The above mentioned reports contained a full description of the physical conditions attendant upon the project for uniting the lakes mentioned with Puget Sound, and of the plan proposed for accomplishing the same.

Briefly stated, they are as follows:

Lake Washington, 19 miles long and averaging 2 miles wide, lies east of Seattle, and is from 2 to 6 miles from Puget Sound. Its ordinary level is 16 feet above high tide in the Sound.

Lake Union lies to the north of Seattle, between Lake Washington and Puget Sound. It has an area of about 1½ square miles. It has no natural connection with Lake Washington, but it has an artificial one, by a small canal used chiefly for lumbering purposes. The fall from Lake Washington to Lake Union is about 6 feet.

From Lake Union there is a small stream flowing to the head of Salmon Bay, distant from Lake Union about 1 mile. From the head of Salmon Bay to deep water in Puget Sound there is a distance of about 3 miles.

The plan outlined in the report of the Board consisted in dredging a channel through the flats of Shilshole Bay from deep water in the Sound to the mouth of Salmon Bay, and there building a lock to overcome the differences of elevation between the Sound and Lake Union.

The lock with a dam would bring the waters of Salmon Bay to the elevation of Lake Union.

The plan further provided for dredging in Salmon Bay to give the requisite depth for a deep-sea harbor, and for the digging of a canal to connect Salmon Bay with Lake Union, and the necessary dredging in Lake Union to reach the head of the lake. Communication between Lakes Union and Washington was provided for by a canal with a lock to overcome the difference of level between the lakes, and by dredging through the shallows of Lake Washington to deep water.

A variation of the plan was to throw a dam across the outlet of Salmon Bay and dig a canal from Salmon Bay to Smiths Cove, and there dredge a channel to deep water in Elliott Bay, building a lock to overcome the difference of level between the waters of Elliott Bay and Lake Union.

The estimated cost of the canal with masonry locks, by the first, or Shilshole Bay route, was $2,900,000, and by the second, or Smiths Cove route, was $3,500,000.

No definite selection of the route to be adopted has yet been made by Congress.

APPROPRIATION.

Act of Congress August 17, 1894..... $25,000

The appropriation has certain conditions attached, and is in the following language:

For dredging Salmon Bay and the improvement of the waterway connecting the waters of Puget Sound, at Salmon Bay, with Lakes Union and Washington, by enlarging the said waterway into a ship canal, with the necessary locks and appliances in connection therewith, twenty-five thousand dollars: *Provided,* That no part of said amount shall be expended on the improvement of the waterway connecting the waters of Puget Sound with Lakes Union and Washington until the entire right of way and a release from all liability to adjacent property owners have been secured to the United States free of cost and to the satisfaction of the Secretary of War.

Report of operations.—The work contemplated by the above-quoted item was assigned to my charge by letter of the Chief of Engineers of August 21, 1894, with instructions to ascertain and report whether the necessary right of way and release from liability as contemplated by the act could be secured to the United States.

An endeavor was made to have a sufficient portion of the appropriation made available for surveying the right of way and marking it upon the ground, and for determining accurately what property would be required to be deeded to the United States, and that from which deeds of release from liability would be required.

But both the Secretary of War and the Comptroller of the Treasury decided that no portion of the appropriation could be expended for expenses connected with the donation of the lands, easements, and releases to the United States.

The duty of making the requisite survey, and of procuring the requisite deeds, easements, and releases, therefore devolved itself fully upon the people of Seattle interested in the work.

An organization was effected in Seattle to accomplish this, but the work made very little progress. During the session of the Washington legislature of 1895 a law was passed giving to county commissioners power of condemnation of property for canal purposes. Through the medium of this law the people interested hope to get the right of way and easements required for the ship canal.

In the sundry civil bill approved March 2, 1895, provision is made for the survey and determination of the lands and easements required. The provision is made in the following language:

That the Secretary of War be, and he is hereby, authorized and directed to expend, from the appropriation of twenty-five thousand dollars "For dredging Salmon Bay and improvement of the waterway connecting the waters of Puget Sound, at Salmon Bay, with Lakes Union and Washington, by enlarging the said waterway into a ship canal, with the necessary locks and appliances in connection therewith," made by the "act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," received by the President August seventh, eighteen hundred and ninety-four, the sum of five thousand dollars in making a definite survey and location of said improvement and in preparing a cadastral map showing each piece of property required to be deeded to the United States, or from which a release is required, with its metes and bounds.

Being informed of this law and directed by the Chief of Engineers to proceed with the survey, Mr. Eugene Ricksecker was employed as assistant engineer and placed in charge of the work with instructions to locate definitely upon the ground the line of the canal selected by the Board of Engineers of 1890, with the requisite right of way as generally laid down and described in the report of the Board, and to deter-

mine with exactitude all data concerning each and every piece and parcel of ground within the limits of the right of way between the low-water line of Salmon Bay and the high-water line of Lake Union, and to prepare maps and lists of all such property. He commenced the active operations of the survey on March 15, 1895.

The work was still in progress at the close of the fiscal year.

Recommendations and remarks.—The surveys of the right of way and flooded lands have not yet been completed, and the right of way and deeds of release have not been received. Nothing has therefore been done toward the actual commencement of operations on the work.

The procurement of the right of way and exemptions from liability is a work of very considerable magnitude and expense, and it is not possible to tell when it will be accomplished. As under the law no work can be done until this matter is fully settled, it is not deemed proper to make any recommendation as to amount of appropriation which could be profitably expended during the next fiscal year.

Future operations.—Work will continue on the survey until it is finally completed, when the maps and property lists, etc., will be submitted for approval, and then turned over to the commissioners or other properly constituted authorities for their action.

Money statement.

Amount appropriated by act of August 17, 1894	$25,000.00
June 30, 1895, amount expended during fiscal year	2,681.06
July 1, 1895, balance unexpended	22,318.94
July 1, 1895, outstanding liabilities	800.00
July 1, 1895, balance available	21,518.94

REPORT OF EUGENE RICKSECKER, ASSISTANT ENGINEER.

SEATTLE, WASH., *June 10, 1895.*

SIR: The last river and harbor bill contained an item appropriating $25,000 "for dredging Salmon Bay and the improvement of the waterway connecting the water of Puget Sound at Salmon Bay with Lakes Union and Washington by enlarging the said waterway into a ship canal with the necessary locks and appliances in connection therewith: *Provided*, That no part of said amount shall be expended on the improvement of the waterway connecting the waters of Puget Sound with Lakes Union and Washington until the entire right of way and a release from all liability to adjacent property owners have been secured to the United States free of cost, to the satisfaction of the Secretary of War."

A survey with estimate for this work was made in 1890, and a Board of Engineers reported on it, indicating upon a map in a general way the several routes proposed.

In the sundry civil appropriation bill of March 2, 1895, Congress authorized the expenditure of $5,000 from the amount previously appropriated "in making a definite survey and location of said improvement, and in preparing a cadastral map, showing each piece of property required to be deeded to the United States or from which a release is required, with its metes and bounds."

The President affixed his signature to the bill on the 2d of March, 1895.

On March 10 I met you in Portland in answer to your telegraphic instructions. After securing material from your office and from several sources in Seattle, and establishing an office in Fremont, a suburb of Seattle, the work was actively begun by placing three parties in the field on the 19th of March.

The proposed improvement, with the exception of the north shore of Salmon Bay, which comprises the water front of the town of Ballard, lies wholly within the limits of the city of Seattle.

The general route of the proposed canal leaves Puget Sound at the mouth of Salmon Bay, traverses the entire length of this bay, thence by a cut to Lake Union, through Lake Union to its eastern extremity, finally entering Lake Washington by a cut across a narrow ridge called the Portage.

The project contemplates making a fresh-water basin out of Salmon Bay, at present a salt-water body navigable at half tide, by raising its waters to and maintaining them on a level with Lake Union by means of a lock at its mouth. It also calls for a lock between Lake Union and Lake Washington.

The work of this survey was the determination of a mean elevation for the surface of Lake Union and the area affected by raising the water of Salmon Bay to the highest level that Lake Union might attain under this improvement; to locate and permanently monument the required right of way upon the ground; to accurately define each tract of land, lot, and fraction within the limits affected, and to determine the present ownership.

This involved the making of an accurate cadastral and topographic survey and map of the vicinity of the proposed improvement.

In the work of the survey all measurements were made with a Roe and a Chesterman steel tape, reading to hundredths of a foot; corrected in the field for temperature and pull, comparisons having been previously made with a recently standardized steel tape from the U. S. Coast and Geodetic Survey.

A triangulation system was extended from a base line measured on the lower Salmon Bay Bridge to a check base near Lake Union.

The Salmon base was measured three times. The range was 0.0172 foot. The mean result, 1,375.7205 feet.

Angles were observed with a 6¼-inch Buff and Berger transit at twelve stations by the method of repetitions, each angle repeated twelve times. The average angle correction was 2.48 seconds.

The mean length of three measurements of the check base was 1,143.7065 feet; the range was 0.0201 foot; the computed length was 1,143.6950 feet. A careful survey of Salmon Bay having been recently made by M. Stixrud for the State harbor line commission and the State board of tide-land appraisers, it was decided to utilize that work in its entirety, supplementing it by the addition of features necessary for this work. The city of Seattle had spent some $1,200 in relocating certain block corners in the Denny-Hoyt addition, and this material was obtained and utilized as far as possible. City Engineer Thompson, with the authority of the common council of Seattle, also worked in conjunction with me in the Ross addition in determining the most probable positions for block corners established without record and many long since destroyed.

All lot and block corners that could be found upon the ground, together with the improvements, were first located. These formed a basis upon which was arranged the presumed intention of the land surveyor, as shown by the County Record of Plats, a record which frequently fails, as in these cases, to show either angles, distances, or sizes of many of the lots. At the Portage, between Lakes Union and Washington, the land had evidently been platted on paper only, making it necessary to subdivide the section inclosing it. An excess of land was found in both directions, which made the fitting of the plat to the ground less complicated. The description of the property by deed was at times confusing. In one case the phrase "easterly 273 feet from the west boundary" proved to be a diagonal line across property which measured 212 feet on an east line. Another case, where the width of a street intended to be 66 feet was 65 feet at one end of an addition and over 90 feet at the other. In all of these additions it is the intention of the city to adopt our location and to monument such street intersections as will permanently establish the additions. Other additions connected with our work were the Ross second, the Gilman, Gilman Park, Ballard, and Bay Terrace.

All computations were based upon a system of rectangular coordinates, the origin placed at such a point in Puget Sound as to be south and west of the entire work.

The meridian for the work is the same as that used by the State in the survey of the harbor, and is approximately 7′ 28″ west of the city's meridian. The datum plane was placed 30 feet below extreme low tide to avoid negative quantities by being safely below the level of any constructive works.

For a period of one year, from August, 1891, to August, 1892, the U. S. Coast and Geodetic Survey maintained an automatic tidal gauge in Seattle Harbor, and from the seven highest tides occurring during that period deduced a value of 15.77 feet for the difference in height between high and low tide. This position of high tide corresponds to 47 feet (46.98) on our datum.

The level of Lake Union was found to vary 3 feet from summer to winter of 1894. It is proposed to maintain it at an elevation of 55 feet, or 8 feet above high tide, allowing a maximum rise and fall of 2 feet. Bench marks were established at intervals of about 800 feet around Salmon Bay and along the waterway to Lake Union.

The flooded area was outlined upon the ground, pegs being placed from 50 to 100 feet apart horizontally. The Portage was connected with Fremont by a line of levels.

Curves of equal elevation at intervals of 2 feet vertically were placed over the area affected from datum to an elevation of 62 feet, or 15 feet above extreme high

tide. This work, as well as the location of all improvements, was done by means of stadia measurements with the plane table. The average length of the shots, excluding those taken at the mouth of Salmon Bay, was 255 feet. Vertical readings on intermediate stations were taken to the nearest tenth of a foot.

The elevations of station points were checked to the nearest hundredth of a foot. Below 47 feet, the level of high tide, the number of locations per 100 square feet average 0.1. Above 47 feet they average 3.4.

Location of the canal.—For convenience of notation the route is divided into eight sections, lettered from A to H, the characteristic features of which are tabled as follows:

Station.	Section.	Length of tangents.	Length of curves.	Curvature.	Bottom width.	Average depth of cuttings.	Excavation.
		Feet.	*Feet.*	° ′	*Feet.*	*Feet.*	*Cu. yds.*
0	A, Shilshole Bay	950	1,900	41 48	300	260	898,800
28 + 50							
	B, lock at entrance	550	.....	.....	120	270	81,400
34							
	C, Outer Salmon Bay	929	880	29 21	300 to 200	90	156,900
52 + 09							
	D, Inner Salmon Bay	5,210	4,581	144 12	200	50	426,900
150							
	E, Fremont Cut	1,760	3,800	6 20	80	250	630,600
205 + 60							
	F, Lake Union	4,521	9,079	331 15	200	40	241,900
341 + 50							
	G, Portage Cut and Lock	2,750	.....	.....	80	400	465,100
369							
	H, Union Bay	4,600	.....	.....	200	150	572,400
415							
	Total	21,270	20,230	552 56	.....	.....	3,474,000

Across the upland (Sections E and G) a right of way 300 feet wide has been asked for. The canal will have a depth of 26 feet, a width of 80 feet on the bottom, and 158 feet at the water surface, with slopes 1½ on 1. Placing the lower berm at 6 feet above the water surface, there will remain 62 feet of land on each side of the canal that will be available in Section E for street purposes, railway lines, etc. In Section G nearly the entire right of way will be required for the cutting.

Section E, the longest cut, deviates but little from a straight line. It extends diagonally across a flat valley, but a few feet higher than Lake Union at its upper end. This valley was platted into lots several years ago. Many of them have been sold, and a number of these are occupied by improvements. A considerable area lying either below the level of the water surface in the canal or cut off from its natural drainage basin by the berm will be more or less damaged. The spoil earth from the canal will likely reclaim the former, while the latter must either be filled with material obtained elsewhere or await the building of a sewer to tide water of sufficient size to carry off the surface drainage. But one class of land is affected in Section G, namely, that included in the right of way.

The following table shows the distribution of the area in the right of way, that which is flooded, and that may be affected. Sections F and H are entirely free navigation.

Section.	Right of way.			Flooded area		Total area.
	Full lots.	Fractional lots.	Total area.	Full lots.	fractional lots.	
			Acres.			*Acres.*
A	3	11	7.82	.....	.....	.....
B	3	7	1.05	.....	.....	2.85
C	9	11	3.30	.....	.....	9.33
D	1	8	.31	407	84	254.74
E	169	195	38.22	295	156	45.26
G	38	4	20.52	.....	.....	.....
Total	.....	.....	71.22	.....	.....	312.18
Grand total area	.....	.....	.....	.....	.....	383.40

The above area includes 167.58 acres of tide lands recently platted by the State of Washington.

Plats and descriptions of each piece of property will be ready for the commissioners of King County the latter part of this month, when it is expected that condemnation proceedings will be instituted by them against the different property holders affected, in conformity with an act passed by the last State legislature, entitled, "An act to grant to, and prescribe powers of, counties relative to public works, undertaken or proposed by the State of Washington or the United States, and declaring an emergency."

When these suits are brought to a close the county will be able to furnish a clean title to the Government for the right of way needed and a release from damages that might be demanded.

The location will be marked by a number of stone monuments before the work is completed.

The route of the canal and vicinity, excepting that portion lyin gin Lake Union, Union Bay and Lake Washington, is being shown on eleven sheets of uniform size, 24 by 30 inches, on a scale of 100 feet to 1 inch, also the important data used or determined. It is expected to complete this work in July.

The changes made in the location of the canal in Section E have met with the general public approval, and give, I believe, an economical route in point of first cost, less valuable right of way, and a reduced excavation, easier maintenance, the absence of sharp curves and attendant bank protection, allowing increased speed for traffic, and a practically straight channel, saving time in transportation.

Physical data.—The following table, taken largely from the Report of Survey, 1890, reduced to this datum, and supplemented by material from this survey, gives the principal data connected with the project:

Elevations.	Feet.		Feet.
Extreme low tide, Puget Sound	30	to	1
Low tide, Puget Sound	31.2	to	1.2
Extreme high tide, Puget Sound	47	to	17
Lake Union, lowest water observed	53	to	23
Lake Union, highest water observed	56	to	26
Lake Washington, lowest water observed	61.6	to	31.6
Lake Washington, highest water observed	63.1	to	33.1
Lake Washington, highest water flood marks	64.4	to	34.4

Areas, depths, etc.		
Salmon Bay:		
Total water area	acres	318
25 feet and over in depth	do	35
Less than 25 feet in depth	do	283
Lake Union:		
Total water area	do	905
25 feet and over in depth	do	499
Less than 25 feet in depth	do	406
Greatest depth	feet	60
Lake Washington:		
Total water area (about)	acres	24,896
25 feet and over in depth (about)	do	22,000
Greatest depth (probably)	feet	600
Lake Samamish:		
Total water area	acres	5,120
25 feet and over in depth (about)	do	4,000
Less than 25 feet in depth (about)	do	1,120
Greatest depth (about)	feet	100
Lake Union drainage basin	square miles	6
Lake Washington drainage basin	do	182
Samamish River drainage basin	do	109
Lake Samamish drainage basin	do	102

Dimensions.	Feet.
Approach to outer lock, depth below extreme low tide	26
Outer lock:	
Width of gates in clear	50
Length of lock chamber in clear	400
Depth of lock in clear	26
Canal excavated in uplands, Fremont and Portage cut, depth	26

Upper lock, same dimensions as outer lock.

Appended hereto is a communication from Mr. Wesley Wilson, manager of the Seattle Coal and Iron Company.

In conclusion I wish to acknowledge courtesies from Civil Engineers Stixrud and Nasten, and City Engineer R. H. Thompson, and to thank the force who have so faithfully aided me in their several capacities.

Respectfully submitted.

EUGENE RICKSECKER,
Assistant Engineer.

Capt. T. W. SYMONS.

LETTER OF MR. WESLEY WILSON, MANAGER SEATTLE COAL AND IRON COMPANY.

SEATTLE COAL AND IRON COMPANY,
Gilman, Wash., May 29, 1895.

DEAR SIR:

* * * * * * *

In shipment of a commodity like coal prompt dispatch in the loading and discharging of vessels cuts a great figure in the cost of transportation. On the northern lakes between Buffalo and Duluth coal is carried at a maximum rate of 50 cents per gross ton of 2,240 pounds, and I have known of coal being transported between Ashtabula, Ohio, and Duluth, Minn., as low as 26 cents per gross ton of 2,240 pounds.

The rates for this service are based largely upon the fact of quick dispatch in loading and discharging. Our rates from Seattle to San Francisco have never, to my knowledge, been below $2 per gross ton, and while we have the disadvantage of having to compete with coals in vessels coming from foreign countries to San Francisco and other coast ports for grain, which they bring at very low rates on account of it furnishing them with ballast, out of which they can make a little something in the transportation, such competition as this tends in a great measure to curtail the output of our mines in Washington, by reason of being compelled to compete with such low rates in the transportation on coal ballast, as above mentioned.

The ebb and flow of the tides, which we would get rid of by having our bunkers erected in fresh water on Lake Washington, would also be a very great advantage in the loading of vessels, as the extremes of the tides on Puget Sound are very great and make it very difficult to load vessels promptly, as we have frequently to wait for the tide to ebb and flow before being able to deliver cargo to vessels.

My firm belief is that if the canal was opened into Lake Washington, so that we would be enabled to erect permanent bunkers and thus be able to give vessels quick dispatch, we would thereby much more successfully compete with the products of foreign countries in our coast markets, which would certainly add very materially to the development of our American coal industries in the great Northwest.

I beg to remain, yours very truly,

WESLEY WILSON, *Manager.*

To EUGENE RICKSECKER, *C. E.*

COMMERCIAL STATISTICS.

Seattle is in the collection district of Puget Sound and is a port of entry.

The following returns relative to the commerce of the port of Seattle were compiled from the statements furnished by Mr. Tracy H. Robertson, secretary of Seattle Chamber of Commerce, and other sources. They are for the fiscal year ending June 30, 1895.

Shipping.

Number of foreign and coastwise vessels arrived	1,378
Aggregate net registered tonnage of same	842,981
Number of Sound steamboats making regular trips from Seattle, mostly daily	68
Number of Sound steamboats making occasional trips from Seattle, by actual count at time of inspection	16
Aggregate net registered tonnage of these 84 steamboats	25,395
Number of Sound ports touched by same	157

Ocean steamers.

The following arrive at and depart from Seattle at regular intervals:

Name.	Draft.	Regular net tonnage.	Route.
	Feet.		
City of Puebla	23½	1,713	San Francisco; one steamer every five days.
Walla Walla	21	2,168	
Umatilla	21	2,168	
Farallon	10½	566	
Willamette	21	1,695	
Alki	17	888	Alaska; two steamers each week.
City of Topeka	18	747	
Chilcat	7½	106	
Willapa	10	250	
Queen	21	1,672	
Signal	23½	392	Portland; every two weeks.
City of Kingston	12½	816	Victoria, British Columbia; daily and triweekly.
Rosalie	10	227	
Evangel	7	97	

The number of passengers, incoming and outgoing, carried by all steamers during the year was 649,332, and the freight handled by all steamers for the same period was upward of 850,000 tons.

Exports and imports by water.

Articles.	Quantity.	Actual value.
EXPORTS.	*Tons.*	
Coal	287,855	$1,007,493
Lumber (119,842,483 feet, B. M.)	239,685	1,078,576
Shingles	8,081	113,134
Laths (167,480 bundles)	4,187	33,496
Pickets	615	22,755
Piles (3,202)	(*)	5,123
Ship and boat spars (437)	(*)	3,512
Wheat and other grain, flour, hops, fruit and vegetables, canned salmon, furs, etc., of which separate quantities unknown	211,654	3,386,464
Total	752,077	6,650,533
IMPORTS.		
General merchandise of all descriptions (not enumerated)	351,782	$5,276,730

* Weight can not be estimated.

SUMMARY.

	Tons.	Value.
Total exports	752,077	$6,650,553
Total imports	351,782	5,276,730

Ship building.

Following is a list of the vessels built at the various shipyards at and near Seattle during the year:

Name.	Rig.	Net tonnage.	Draft, loaded.	For what trade.
			Feet.	
Maria	Sloop	6.36	3.3	Fishing.
Comet	do	5.42	5	Pleasure.
Lizzie B	Schooner	20.50	5.8	Fishing.
Penguin	do	31.88	7.1	Do.
Enigma	Steamer	19.66	5.6	Coasting.
White Star	Sloop	8.18	5.9	Pleasure.
Electo	do	8.48	4.5	Fishing.

Ship building—Continued.

Name.	Rig.	Net tonnage.	Draft, loaded	For what trade.
			Feet.	
Bering Sea	Schooner	46.18	7	Sealing.
Alley	do	5.76	3.6	Fishing.
Prospect	Sloop	25.88	6.9	Coasting.
Lillie and Maud	Schooner	7.65	4.8	Do.
City of Bothen	Steamer	30.77	3.4	Do.
Oriole	Sloop	7.36	3.5	Do.
Vigilant	Steamer	25.22	9.3	Coasting (tug).
Trilby	Schooner	10.17	3.6	Coasting.
Nancy	Sloop	8.04	3.1	Fishing.
Apollo	do	5.11	3	Pleasure.
Ben	do	6.79	3.3	Fishing.
Eclipse	Steamer	7.84	4	Coasting.
City of Shelton	do	138.39	6	Do.
Mystic (rebuilt)	Steamer	13.76	4	Coasting (tug).
M. M. Morril	Schooner	43.19	7.8	Sealing.
Rob Roy	do	10.15	4	Fishing.
Loyal	do	26.50	5.8	Do.
Liberty	Sloop	10.39	4.5	Do.
Kate	do	10.89	4	Do.
Alice	do	7.49	3.6	Do.

Industries (present).—The last United States census gave evidence of 331 manufacturing establishments, 4,048 employees, and $10,203,007 finished products. Since this census there have been added more than 100 new industries, including 7 saw and shingle mills, a flour mill, woolen mill, packing house, pressed brick and fireproofing works, baking powder and spice manufactory, 6 box factories, a carriage factory, 2 broom factories, 2 tanneries, a pickle and vinegar works, artificial stone works, boat and naphtha launch factory, boiler works, tinware manufactory, and 2 shipyards.

Industries (new and prospective).—(1) Ship canal connecting Puget Sound with Lake Washington; (2) excavations of deep waterways and basins in the tide flats of Seattle Harbor, and a ship canal from the harbor to Lake Washington, and with the material filling in of 1,700 acres of tide lands in Seattle Harbor; (3) Snoqualmie power plant (to generate power for Seattle factories and street railways; energy of falls, 51,000 horsepower); (4) Cedar River power plant (same purpose as above); (5) car manufactory and steel works; (6) glass works; (7) Acetylene works; (8) flour mill; (9) opening of Renton coal mine (now in successful operation); (10) pottery works; (11) packing house; (12) coffee and spice mill.

T T 19.

IMPROVEMENT OF EVERETT HARBOR, WASHINGTON.

This is a new work, the first appropriation for it having been made in the river and harbor bill of August 17, 1894.

Description of original condition.—Everett is situated on a peninsula, one side and the end of which is bounded by the Snohomish River and the other side by the waters of Puget Sound. Of the water front on Puget Sound but a small part has deep water, the remainder fronts on the tide flats which have been formed by the Snohomish River.

A portion of the river forming the rear or fresh-water boundary of the peninsula has navigable depths sufficient for all ordinary purposes of commerce, but below this, and especially across the tide flats at the mouth, the water is shallow, and great difficulty is experienced in getting into the fresh-water river harbor back of the city.

Plan of improvement.—The plan of improvement adopted for this work is understood to be that prepared by me and submitted under date of July 9, 1894, and described in Senate Ex. Doc. No. 139, part 2, Fifty-third Congress, second session. The plan may be generally described as follows:

First, to excavate a harbor basin in the shallows and tide lands adjoining deep water near the river's mouth; second, to dredge a channel from this through the tide flats and the Old River mouth to deep, fresh water in the Snohomish River, this channel being designed to bring fresh water to the harbor basin and to afford facilities for navigation about the peninsula and into the deep water bounding the peninsula on the east; and third, to protect and maintain this harbor and channel across the tide flats by a bulkhead interposed between them and the open waters of the Sound, the bulkhead to act as a retaining wall for the material dredged from the harbor. The estimated cost of the work is $372,000.

APPROPRIATION.

Act of August 17, 1894 ..... $10,000

The language of the act is as follows:

For dredging Everett Harbor, including the mouth of Snohomish River, and Snohomish River from mouth to Lowell, in the State of Washington, the sum of ten thousand dollars.

Amount expended to June 30, 1895.—The amount expended on the project to June 30, 1895, was $84.79.

Results obtained to June 30, 1895.—The work having but fairly commenced, no results of value can yet be claimed.

Report of operations.—The language of the law confined the work to be done to *dredging.* The proper conduct of the work required that the work of dredging should be preceded by a retaining bulkhead to impound the dredged material and to shelter the dredged channel from outside wave action. As this retaining bulkhead could not legally be built with the money appropriated, it was decided that the expenditure of the appropriation should be delayed until the defect in the law could be cured or until the necessary bulkhead could be built through some other means.

On February 1, 1895, a joint resolution of Congress was approved, making the requisite change in the law.

This resolution is as follows:

That the appropriation of ten thousand dollars heretofore made for dredging Everett Harbor, at Everett, in the State of Washington, may be used by the Secretary of War in the construction of a fresh-water harbor at Everett, in said State, in accordance with the project submitted by Captain Thomas W. Symons, of Corps of Engineers, United States Army, on July ninth, eighteen hundred and ninety-four, and printed in Senate Executive Document numbered one hundred and thirty-nine, part two, second session of the Fifty-third Congress.

The resolution was received from the Chief of Engineers, with instructions to prepare and submit a project for the expenditure of the $10,000 appropriated for the construction of a fresh-water harbor at Everett.

Under date of February 14, 1895, a project for the work was submitted, which, in brief, consisted in building a bulkhead from the lower end of Smiths Island along the bulkhead line hitherto established by the Secretary of War, the work to extend to such a length as the prices bid for it would permit.

The work was advertised, and on May 18, 1895, bids were opened. The following is an abstract of those received:

No.	Name and address of bidder.	Piles, per linear foot.	Lumber, per M feet, B. M.	Spikes, per pound.	Brush, per cord.	Total.
		Cents.		*Cents.*		
1	J D. Wickliff, Portland, Oreg	11	$9.00	2	$i.65	$5,935.00
2	J. J. Maney, Everett, Wash	6½	8.50	4½	1.46	4,460.00
3	Bogart & Conway, Seattle, Wash	9	8.00	5	3.25	7,805.00
4	R. V. Tompkins, Everett, Wash	9	8.00	5	2.50	6,680.00
5	Savage & Scofield, Olympia, Wash	7½	9.75	3¼	2.23	5,922.50
6	J. F. Hart Lumber Co., Everett, Wash	7½	9.75	4	2.45	6,267.50
7	Dickinson & Co., Tacoma, Wash	8	11.00	3½	1.75	5,405.00
8	Edwards & Birney, Everett, Wash	6	9.00	4	1.74	4,760.00
9	Frank Twombly, Seattle, Wash	9½	9.94	6	1.97½	6,144.50
10	F. A. Keafal, Tacoma, Wash	8	8.25	3½	2.65	6,617.50
11	Timothy G. Collins, Everett, Wash	5¼	9.50	3½	1.75	4,587.50
12	Dwyer & Amory, West Superior, Wis	10	10.00	5	2.65	7,275.00
13	Pacific Dredging Co., Tacoma, Wash	7½	10.00	3½	2.15	5,820.00
14	Chas. King, Tacoma, Wash	7	9.75	3	1.74	5,047.50
15	Everett Terminal Co., Everett, Wash	5	7.70	3	1.25	3,760.00
16	King & Marrinan, Seattle, Wash	6⅞	12.00	3½	1.48	4,746.25

The contract was awarded to the Everett Terminal Company. Pile driving started on the last day of the fiscal year.

Recommendations and remarks.—Everett has been established as a "city of industries," and every inducement is held out to people to start industrial enterprises of all kinds. A considerable number have already been started, and most of the principal ones are situated on the fresh-water frontage of the peninsula, for economic reasons and because this frontage is best suited topographically for the purpose. All of these industries are deeply interested in the projected deep-water entrance to the river.

One of the most important of these industries is the Pacific Steel Barge Works, situated on the Old River about halfway between its mouth and its head. It was here that iron shipbuilding was inaugurated in the Pacific Northwest. The iron whale-back steamer *City of Everett* was built here and launched October 24, 1894. This steamer has a carrying capacity of 4,000 tons, and has, ever since her launching, been busily engaged in ocean commerce, principally in carrying coal from Puget Sound to California ports. The *City of Everett* can now only reach the Barge Works on the highest tides and when entirely without load. It is desirable that for purposes of repairs she should be able to go to the works at almost any time. As the construction of other ships will probably soon follow, the importance of the contemplated harbor improvement to this industry must be apparent.

Another industry is the Smelting Works, near the Steel Barge Works. The ores smelted here are from the Monte Christo mines, those brought from various interior points by the Great Northern Railroad, and ores brought from all along the Pacific Coast by water.

Another and very important industry is the paper mill situated at Lowell, on the Snohomish River. This mill manufactures fine grades of book, writing, and wrapping paper exclusively, and a large part of its product is shipped to foreign countries, particularly to Australia, New Zealand, and China. This mill is putting in new plant and adopting new processes to increase and vary its product.

These industries and others of a minor character, as sawmills, shingle mills, iron works, tile works, etc., situated on the interior river harbor, would be greatly benefited by the proposed harbor improvements.

It is also expected that as soon as the channel can be excavated and the waters of the Old River confined that very valuable benefits will accrue to the nail works and the existing wharves in the deep salt-water portion of the harbor by the fresh water coming down and preventing or materially limiting the action of the teredo.

Attention is invited to the very low prices at which the work at Everett is being done. The contractors are a local firm, who state that they took the work at the lowest possible prices without hope of gain, in order that the greatest possible amount could be done with the funds available. First-class piles are to be furnished and put in the work, at 5 cents per foot; lumber in the work, at $7.70 per thousand feet, B. M., and brush filling in the dike, at $1.25 per cord.

It is expected that about 4,000 feet of dike will be built with the money available and completed to a height sufficient to commence dredging operations.

An appropriation of $150,000 is recommended as the amount which can be profitably expended on the project during the fiscal year ending June 30, 1897. With this amount the dike can be built to its full length and a good serviceable harbor basin dredged.

Future operations.—Work will continue under the contract to as great an extent as the available funds will justify. It is expected that work will be completed under the contract during the present season.

Money statement.

Amount appropriated by act of August 17, 1894		$10,000.00
June 30, 1895, amount expended during fiscal year		84.79
July 1, 1895, balance unexpended		9,915.21
July 1, 1895, outstanding liabilities	$100.00	
July 1, 1895, amount covered by uncompleted contracts	3,670.00	
		3,770.00
July 1, 1895, balance available		6,145.21
Amount (estimated) required for completion of existing project		362,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		150,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

COMMERCIAL STATISTICS.

Everett is in the collection district of Puget Sound and is a subport of entry.

The following returns are furnished by Mr. Schuyler Duryee, general manager of the Everett Land Company, and are for the fiscal year ending June 30, 1895.

Shipping.

Following is a list of steamers touching at Everett, on the Tacoma, Seattle, down Sound, and ocean routes:

Name.	Registered net tonnage.	Draft, loaded.	Propelling power
		Feet.	
Walla Walla*	2,168	21	Propeller.
Umatilla*	2,168	21	Do.
City of Puebla*	1,912	24	Do.
Queen*	1,672	21	Do.
Mexico*	1,341	21	Do.
Farallon*	565	18	Do.
Cricket	49	5	Do.
Rapid Transit	82	6	Do.
Angeles	44	8	Do.
State of Washington	449	6	Stern-wheel.
Fairhaven	240	5	Do.
Mabel	114	4	Do.
Greyhound	160	5	Do.
Clan McDonald	118	4	Do.

Those marked * are ocean steamers; they call at intervals of five days, bringing general merchandise and passengers from San Francisco and clearing with freight from mills and factories.

River traffic.

The following boats ply upon the Snohomish River between Everett and Snohomish City, touching at all way points; they carry passengers and freight:

Name.	Registered net tonnage.	Draft, loaded.	Propelling power.
		Feet.	
Mikado	19.9	4	Propeller.
Katharine	14	4	Do.
Mabel	114	4	Stern-wheel.
Mame	43	2	Do.
Clan McDonald	118	4	Do.

The steamers *Katharine* and *Mikado* are almost exclusively passenger boats, making eight trips daily, and average only about 200 pounds of freight each trip. The steamer *Mame* runs twice a week between Snoqualmie and Everett and averages 10 tons of freight each trip, in addition to passengers. The steamer *Mabel* carries both passengers and freight and runs from Seattle to Everett and Snohomish three times a week, and averages 20 tons of freight per trip. The steamer *Clan McDonald* carries both passengers and freight, makes six trips a week between Seattle, Everett, and Snohomish, and averages 25 tons of freight per trip.

Exports (by water).

Articles.	Quantity.	Value.
	Tons.	
Lumber (96,000 feet, B. M.)	192	$864
Shingles (no water shipments)	1,755	2,160
Nails	4,200	168,000
Paper	3,000	240,000
Product of smelter (bullion)	1,440	422,568
Hay	400	3,200
Grain	200	3,000
Total	11,187	839,792

The total lumber cut of the several mills during the year was 27,000,000 feet.
The total shingle cut of the several mills during the year was 162,000,000.
These products were shipped east by rail.

Imports.

Articles.	Quantity.	Value.
	Tons.	
General merchandise, groceries, etc	9,800	$490,000
Machinery and agricultural implements	840	16,800
Ore, for reduction works	13,212	476,490
Miscellaneous freight	37,480	(*)
Coal and coke	7,400	22,200
Total	68,732	1,005,490

* Unknown.

SUMMARY.

	Tons.	Estimated value.
Total exports (by water)	11,187	$839,792
Total imports	68,732	1,005,490
Total lumber and shingle exports (by rail)	135,000	571,000

Improvement of EVERETT HARBOR, WASHINGTON.

Showing Plan for fresh water Harbor proposed and covered by estimate of July 9th 1894, as submitted by

CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

Scale

ft. 1000 500 0 1000 2000 ft.

Datum plane for soundings is the mean of the three lowest tides observed in July, 1893. Soundings are in feet below this datum. Minus soundings (-5) are above this datum.

Dike under construction shown thus ——

To accompany annual report of 1895

T. W. Symons

Captain Corps of Engineers

PLAN OF IMPROVEMENT

This project contemplates a harbor basin in front of the Everett Peninsular, 200 ft wide, 2300 ft long, and 26 ft deep at mean lower low water, and a navigable inlet channel 100 ft wide and 6 ft deep from the end of the basin around the peninsular to the head of Old River. The excavated material to be deposited behind dikes or bulkheads.

APPROPRIATION

Act of August 17th 1894 ..... $10,000.

PORT GARDNER BAY

DIKE NOW CONSTRUCTING UNDER CONTRACT

SMITH'S ISLAND

Flat land; elevation 13 ft.

Union Slough

Old RIVER

Flat land; elevation 14 ft.

Flat land; elevation 15 ft.

PIER HEAD LINE

BULKHEAD LINE

200 ft. Roadway

Shingle Mill

Everett Land Co. Saw Mill

HARBOR BASIN

Entrance Locks

Merchants Wharf

Puget Sound Wire Nail and Steel Co's Works

Puget Sound Reduction Co's Smelter

Pacific Steel Barge Co's Works

GREAT NORTHERN RAILWAY

EVERETT & MONTE CRISTO RAILWAY

MONTE CRISTO AVE. Electric Ry.

EVERETT AVE. Electric Ry.

HEWITT AVE. Electric Ry.

CALIFORNIA AVE.

WALL ST.

PACIFIC AVE.

GRAND AVE.

HIGHLAND AVE.

SUMMIT AVE.

Hart Saw Mill

Proposed Dam

Steamboat Slough

Everett Chair Co.

Mosaic Tile Works

Sumner Iron Works

Spittles Wharf

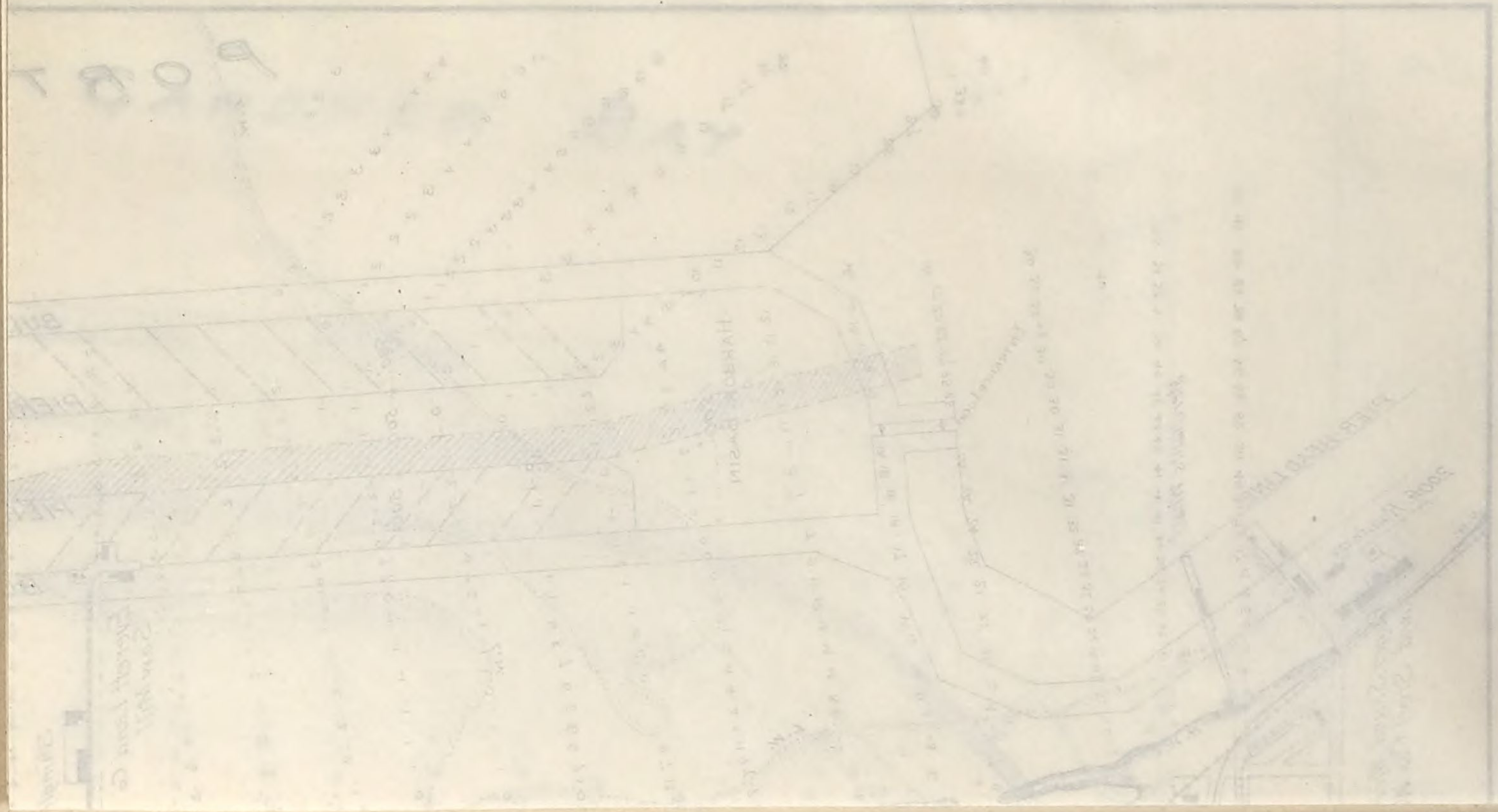
Pacific Ave. Wharf

Snohomish River

Deadwater Slough

Drawn By A. Downing

Eng 54 1



Vessels built.—The steamer *City of Everett*, of the whale-back type, was built and launched from the Pacific Steel Barge Company's yards, on October 24, 1894. Her dimensions are as follows: Length over all, 361 feet; breadth amidships, 42 feet; depth of hold, 28 feet; draft, loaded, 19 feet; registered tonnage, net, 1,858.28. She is now carrying coal between Comox, British Columbia, and San Francisco, Cal.

Schooner *Dauntless*, launched May 20, 1895. Her dimensions are as follows: Length over all, 43 feet; breadth amidships, 13 feet; depth of hold, 5 feet; draft, loaded, 6 feet; tonnage, gross 18, net 14.

New industries.—(1) Feed mill having a capacity of 65 tons a day; (2) sulphite mill having a capacity of 10 tons of wood pulp per day; (3) shingle mill having a capacity of 100,000 shingles per day; (4) an extensive wooden-box factory is in course of construction.

T T 20.

IMPROVEMENT OF SWINOMISH SLOUGH, WASHINGTON.

The first appropriation for this work was made in the river and harbor act approved July 13, 1892.

Description of original condition.—Swinomish Slough is a tidal slough connecting the waters of Saratoga Passage and Skagit Bay on the south with Padilla Bay on the north. It is an important water highway, furnishing the most easterly, the shortest, and safest route for the smaller class of steamboats between the northern and southern waters of Puget Sound. It skirts the Skagit Delta, the richest and most extensive agricultural region of western Washington. It is, however, shallow and crooked in some portions, and the approaches to it are across the shallow flats of Padilla Bay on the north and Skagit Bay on the south.

Swinomish Slough is the ordinary meeting place of the tides, although at times the tides run in one direction entirely through.

The ordinary rise and fall of the tides in the slough is about 8 feet. As a general thing throughout the slough there was an abundant depth of water. Opposite La Conner there was 10 to 15 feet at low water; just south of La Conner this increased to 34 feet, while at the northern entrance to the "Hole in the Wall" there was a depth of 40 feet at low water.

Where the slough widens out, and especially where the Indians have been in the habit of putting fish traps, this depth decreases, so that there is not over 2 feet at low water in any practicable channel. What channel there is is very crooked.

At the northern end the slough opens out into the flats, forming the southern portion of Padilla Bay, in the midst of diked land and marshes.

At the southern end of the slough there are two passages connecting the slough with the waters of Skagit Bay. These passages are separated by a rocky island called McGlinns Island.

The east passage is wide and shallow, having nowhere more than 2 feet depth at low water. The west passage between McGlinns and Fidalgo islands is at the narrowest place 220 feet wide, with an ample depth of water for all purposes.

This short and crooked passage is so situated with high, rocky bluffs on either side that one can not see through from one end to the other.

On account of its character it has received and is known by the very descriptive title of the "Hole in the Wall."

This is the passage used almost exclusively by steamers.

Plan of improvement.—The plan of improvement adopted is to dredge a channel 4 feet deep and 100 feet wide from deep water in Saratoga Passage across Skagit Flats, through the shoals of the slough proper, and across the flats of Padilla Bay to deep water, and to build dikes in Skagit and Padilla bays to direct the ebbing and flooding waters through the dredged channels.

The estimated cost of the work is $122,000.

APPROPRIATIONS.

Act of—	
July 13, 1892	$25,000
August 17, 1894	25,000
Total	50,000

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $23,774.55.

Results obtained to June 30, 1894.—A wattled pile dike was constructed 6,180 feet long, extending from a point 400 feet west from the entrance to the "Hole in the Wall" to a point 300 feet distant from the northwest point of Goat Island.

Also a channel was dredged 6,120 feet long, having the specified depth of 4 feet at mean lower low water, or 2 feet at extreme low water, and a bottom width of 100 feet.

This channel extends from the "Hole in the Wall" westwardly, passing just north of Goat Island.

Amount expended during the fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $20,486.02.

Results obtained during the fiscal year ending June 30, 1895.—In addition to work done during preceding years, a dike consisting of a single row of piles was built between Goat and Ika islands, and a channel dredged through Swinomish Slough proper, so that at all points between the upper end of the slough and La Conner there is a waterway at least 100 feet wide and 4 feet deep at low water.

Report of operations.—Under date of September 27, 1894, the work of improving Swinomish Slough was advertised. The work to be done consisted in building a pile dike between Goat and Ika islands and in dredging a channel 4 feet deep at low water and 100 feet wide through the slough proper wherever it might be necessary.

The following is an abstract of the bids received:

No.	Name and address of bidder.	Dredging, per cubic yard.	Dike building, per foot.	Total.
		Cents.	*Cents.*	
1	Dickinson & Co., Tacoma, Wash	.....	8½	$2,380
2	Bowers Dredging Co., Portland, Oreg	16	.....	17,600
3	King & Marrinan, Seattle, Wash	.....	8½	2,380
4	Chas. King, Tacoma, Wash	.....	8½	2,380

Contract for dredging was awarded to the Bowers Dredging Company and for the dike building to King & Marrinan. The latter commenced operations November 15, 1894, and on January 31, 1895, completed the pile dike between Goat and Ika islands. In this dike there were 1,021 piles driven of a total length of 28,240 feet.

The Bowers Dredging Company commenced operations March 8, 1895. Work was started at the north end of the slough in the vicinity of the railroad and county bridges, where work was most needed to give through navigation. The material was pumped over into a slough to the west of the main slough. After completing the necessary work in the vicinity of the bridges, the dredger moved south to La Conner and worked north, the dredged material being deposited behind bulkheads of brush and straw, and high up on the bank.

Work continued until May 31, 1895, when operations ceased. During the period of active operations there was excavated within the contract limits the amount of 95,953.26 cubic yards of material. Much more than this was excavated for which the contractors received no pay.

While the work was in progress careful surveys were made of the northern approach to the slough across the Padilla Flats and of the southern end of the slough between Gallaghers Point and the "Hole in the Wall." These surveys will form the basis for future work.

Recommendations and remarks.—Swinomish Slough is an important highway for commerce, connecting the northern and southern portions of Puget Sound, forming the shortest and safest route between them. It passes through what is probablythe most fertile and productive portion of the State of Washington. Upon it is situated the town of La Conner. Very great inconvenience is experienced by boats using the slough, due to shallow water.

It is very desirable that the slough be fully opened with the least delay practicable, and it is therefore recommended that the full amount to complete the project be appropriated namely, $72,000.

Future operations.—If sufficient money be left after dredging operations cease it is probable that a small dike to close Telegraph Slough will be recommended to be built, as this seems to be necessary to maintain a good channel through Swinomish Slough. If this is not done it is probable that nothing will be done until another appropriation becomes available.

Money statement.

July 1, 1894, balance unexpended	$1,225.45
Amount appropriated by act of August 17, 1894	25,000.00
	26,225.45
June 30, 1895, amount expended during fiscal year	20,486.02
July 1, 1895, balance unexpended	5,739.43
Amount (estimated) required for completion of existing project	72,000.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	72,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

REPORT OF MR. E. L. CARPENTER, INSPECTOR.

PORTLAND, OREG., *June 12, 1895.*

CAPTAIN: I have the honor to submit the following report of operations in improving Swinomish Slough, Washington, for the fiscal year ending June 30, 1895:

The operations contemplated under the appropriation of $25,000 by the river and harbor bill of August 17, 1894, were the driving of a line of piles between Goat and Ika islands and the dredging of Swinomish Slough to a depth of 4 feet at mean lower low water between the Seattle and Northern Railroad Bridge and La Conner.

Pile dike.—A contract was entered into November 5, 1894, with King & Marrinan, of Seattle, to furnish and drive the line of piles between Goat and Ika islands, at the rate of 8½ cents per linear foot. Work was started November 15, with Mr. J. W. Graff as inspector.

The piles were driven 4 feet apart between centers, with their tops at or above extreme high water, which was taken as the 16-foot mark on the Goat Island gauge. The penetration was 12 feet, or as much more as was necessary in the opinion of the inspector. The bottom in nearly all parts of the line was very solid, and considerable difficulty was experienced in driving the piles.

Owing to the inclement season of the year, the work was very much delayed by bad weather, especially as the space between Goat and Ika islands is very much exposed and the slightest wind will raise considerable sea.

The average number of piles driven per working day was 26. The total number of piles driven was 1,021 and total length 28,240 feet. The average length of the piles was 27.6 feet, the average penetration 15 feet, and the piles projected, on an average, 1.5 feet above extreme high water.

The weight of the pile-driver hammer was 3,500 pounds, and the average number of blows per pile was 56.5, the greatest number being 170 and the least number 6.

The work of driving the piles was finished January 31, 1895, and the cost, exclusive of inspection, was $2,400.

Present condition.—Upon recent examination this line of piles was found to be in good condition and to be causing in some places an accumulation of sand and shoaling of some of the small channels crossing its line. No drift has been collected, however.

Dredging.—A contract was entered into with the Bowers Dredging Company November 7, 1894, to do the necessary dredging in certain parts of Swinomish Slough north of La Conner, so as to make a channel with a bottom width of 100 feet and a depth of 4 feet at mean lower low water.

The estimated amount of dredging to give a channel of the above width and depth from the Seattle and Northern Railway Bridge, according to the original location, was 110,000 cubic yards.

Owing to certain changes in the location of the channel to be dredged, and from a certain amount of shoaling of the slough, the actual amount of excavation would have exceeded the original estimate by about 17,000 cubic yards, but on account of some trouble experienced in obtaining the right of way for the cut through the point near Whitney's barn, this cut, amounting to 31,000 cubic yards, was not made, leaving the actual amount of dredging about 96,000 cubic yards.

About the shoalest place in the slough was the stretch from the railway bridge south for about 2,500 feet, and this was the part that was first dredged.

The survey for the estimation of quantities was started February 26, 1895, preliminary to dredging.

A base was measured on the railway track and the triangulation extended south therefrom. Signals were erected and located by cuts from the triangulation points and everything prepared for a survey by the use of two sextants.

The channel was staked out and located as shown on maps accompanying. Much of the bottom went bare at low water, and such parts were simply cross sectioned at intervals of every 20 feet by instrumental or water levels.

Where the channel to be dredged joined on to the deep water at either end it was necessary to run some sounding lines, locating points on the same by simultaneous observations with two sextants.

The dredger arrived on March 4 and began work on March 8, 1895.

This portion of the work contained 35,219.05 cubic yards of dredging and involves the cutting of a channel 2,200 feet in length. The material excavated from this stretch was deposited upon the Swinomish Indian Reservation, on an average of about 1,000 feet to the west of the channel, and it was used in filling up some of the small sloughs, thus leveling up the land.

This section of the dredging work was completed March 31, 1895, and as soon as the weather would permit the dredger was towed to La Conner and started cutting north from the town.

In the meantime the slough for about 2 miles north of La Conner had been triangulated and signals erected for sounding, the channel staked out and sounded by the use of two sextants for a distance of about 10,000 feet. These soundings were platted on a scale of 100 feet to the inch and from this map cross sections were taken and platted and the sectional areas computed. In this way the amount of excavation from La Conner north to the red barns owned by Mr. Osburg was found to be 60,734.21 cubic yards.

Along this portion of the work the sand excavated from the slough was deposited on the tide flats between the dikes and the slough and retained by straw and brush levees. In this way the sand was not only kept out of the slough but also made to be of service to the farmers in protecting their dikes.

Quite a fill was made behind a small island, the face of the fill being protected by loose brush, about 12 feet in length, which formed a cheap but effective bulkhead.

The excavated material was also used to dam off Whites Slough, a small slough about 1¼ miles north of La Conner. Loose brush was laid across the slough at low

water and sand pumped in behind, more brush being put in as the fill was raised. In this way a dam about 200 feet wide and 16 feet above mean lower low water was put in, a box having been previously put in to carry off the drainage water.

In some places the banks of the slough having been caving off considerably from the action of the water, especially where it was rough, the owners of the land protected their banks by furnishing brush to the contractors, who would thereupon retain the filling with brush laid at about an angle of 30 degrees with the line of the fill, which sloped back about as fast as it was raised.

The channel excavated from La Conner north was 10,420 feet long, the completed channel being about 110 feet wide on the bottom and from 4½ to 5 feet deep at mean lower low water, the extra excavation being a measure of safety on the part of the contractors.

The material excavated was almost entirely sand. On one stretch of channel 400 feet long, opposite Whites Slough, small bowlders about the size of a man's head were met with, and at the extreme northern end of the La Conner cut, a fish trap composed of small sticks and mud was encountered.

The following table shows the progress by months:

Month.	Number of working days.	Amount of material removed.
1895.		*Cu. yards.*
March	20	35,500
April	22	21,500
May	27	38,953.26
Total	69	95,953.26

From the above it is seen that the amount of excavation per working day was 1,390.6 cubic yards.

The total cost of the dredging, exclusive of inspection, was $15,352.52.

Present condition.—Upon recent examination, the dredged channel between the county drawbridge and the Seattle and Northern Railroad Bridge was found to be cutting considerably deeper, it being from 7 to 9 feet deep at mean lower low water, and the old channel west of the railroad bridge was filling in.

Tide gauges.—On February 3, 1895, a tide gauge was put up on the drawrest of the county drawbridge, and the tides observed on this gauge until March 8, 1895. From the tides thus observed it was found that the mean of the lower low waters was 2.24 feet above the zero of the staff, but for the purpose of dredging the mean of the lower low waters was assumed to be 2 feet above the zero of the gauge.

The gauge was referenced to the steel casing of the concrete drawpier of the Seattle and Northern Railroad Bridge.

A tide gauge was also put up on the southwest corner of the wharf on McGlinns Island. Its zero is 1.3 below the mean of the lower low waters.

The tide gauge at La Conner was replaced by a new one with the feet and tenths cut into the wood. The zero of the new gauge is the same as that of the old one, viz, 3.84 below mean lower low water.

The tides in Swinomish Slough are very uncertain, being affected very greatly by local conditions, but it may be said that the tides flooding to the north are stronger than any others, and after the "long run outs" the tide usually rises 3 feet in the first hour.

I am of the opinion that the only effect the dredging will have on the tides is that the low tides will be slightly lower, the water not being obstructed by bars as was formerly the case.

Surveys.—Other than those for the purpose of determining the quantities of dredging, the following surveys were made by the use of two sextants:

In April, a survey of the junction of Telegraph and Swinomish sloughs.

In May, a survey of Padilla Bay for about 6,000 feet north of the Seattle and Northern Railroad Bridge, to determine the amount of dredging required to excavate a channel north from the bridge to deep water in Padilla Bay, the former estimates being based upon very insufficient data.

A survey was also made in May of that portion of Swinomish Slough lying between La Conner and the "Hole in the Wall" for the purpose of ascertaining the amount of dredging necessary, and to obtain data from which to estimate the cost of a dike between Gallaghers Point and McGlinns Island.

The soundings taken in this survey were referenced to the gauge on the wharf at McGlinns Island.

The soundings taken in the Telegraph Slough and Padilla Bay surveys were referenced to the tide gauge on the county drawbridge.

Condition of old work in Skagit Bay.—Upon recent examination the wattled dike in Skagit Bay was found to have suffered the loss of a few more piles between the gap reported earlier, making a total of 20 piles. The last few that went out have been in a precarious condition for sometime past.

The old channel toward seal rocks following the south shore of Fidalgo Island has developed slightly within the past few months but is still very shoal, as the sand is banked up behind the wattled dike to a noticeable extent. This channel will carry from 1 to 2 feet of water at mean lower low water.

The dredged channel is still in good condition and has a depth throughout in excess of 4 feet at mean lower low water and has also widened out from about 100 to 250 feet. In one place the depth is not as great as upon the completion of the dredging in January, 1894. This is about 1,000 feet east of Goat Island, and the shoaling is undoubtedly caused by what is known locally as the Utsalady current, which at the first of the flood tide sweeps around the east end of Goat Island in a northerly direction toward the extreme southwest end of Fidalgo Island.

Between the east end of Goat Island and this particular portion of the dredged channel the tide flats are swept perfectly clear of sand, leaving the mud exposed.

The channel from the end of the dredged channel to deep water in Saratoga Passage is in good condition, though a little crooked, and has a governing depth of about 4 feet at mean lower low water.

A couple of the piles used to mark this channel have gone out, but a spar buoy is about to be put in to mark the principal turn in it, which will leave the channel well marked.

Five spar buoys are also about to be placed in the principal turns in the channel through the Padilla Bay Flats and, as range beacons were erected through the slough, the whole channel is well marked.

Completion of project.—The original project for the improvement of Swinomish Slough provided for a channel 100 feet wide at the bottom and 4 feet deep at mean lower low water, extending from deep water in Skagit Bay, across Skagit Bay Flats, through Swinomish Slough, and extending across the Padilla Bay Flats to deep water in the latter bay.

Under the appropriation of July 13, 1892, and August 17, 1894, the project has been completed to the extent of dredging 19,820 feet of channel, building 6,200 feet of wattled dike in Skagit Bay, and putting in a pile dike between Goat and Ika islands.

I have estimated that to complete the project the following amounts of dredging and dike building will be required:

Dredging:			
Skagit Bay	cubic yards	42,000	
Swinomish Slough	do	62,500	
Padilla Bay	do	104,000	
Total	do	208,500, at 16 cents	$33,360
Dike building:			
Wattled and brush dikes—			
Skagit Bay	linear feet	3,170	
Padilla Bay	do	5,400	
Total	do	8,570 at $1	8,570
Pile, brush and stone dike:			
Swinomish Slough	do	2,100	13,000
Telegraph Slough	do	500	2,500
Total			57,430
Contingencies, 10 per cent			5,743
Total			63,173

Future operations.—With the next appropriation that is available I would recommend the completion of the project between La Conner and the "Hole in the Wall," and on the completion of this, if there should be any money left, to cut off the point near Whitney's barn.

The dike between Gallaghers Point and the northern end of McGlinns Island should be, I think, built first, as, in my opinion, there is a large quantity of sand being deposited constantly, by means of the channel between McGlinns Island and the mainland. At low tide, and when the tide begins to flood, the water from the north fork of the Skagit River rushes through this channel, impregnated with sand which is carried into Swinomish Slough and deposited there.

To build this dike, dredge the channel between Gallaghers Point and the "Hole in the Wall," and make the cut-off near Whitney's barn, will require:

Dredging:			
Gallaghers Point to "Hole in the Wall"	cubic yards	28,000	
Cut-off near Whitney's barn	do	32,000	
Total	do	60,000, at 16 cents	$9,600
Dike building:			
Gallaghers Point to McGlinns Island	feet	2,100	13,000
			22,600
Contingencies, 10 per cent			2,260
Total			24,860

To complete the project from the Seattle and Northern Railroad Bridge to deep water in Padilla Bay would require:

Dredging Padilla Bay, 104,000 cubic yards, at 16 cents	$16,640
Brush dike, Padilla Bay, 5,400 linear feet, at $1 per foot	5,400
	22,040
Contingencies, 10 per cent	2,204
Total	24,244

At the junction of Telegraph and Swinomish sloughs a very dangerous bar exists, caused by the tidal discharges from Telegraph Slough. This bar shifts considerably, but is usually in the form of a long, narrow spit, extending from the west bank of Swinomish Slough toward Telegraph Slough, and at low tide extending clear across to the east bank.

I believe that the only way to remove this bar would be to build a dike across the mouth of Telegraph Slough. As this slough is closed at its northern end by three or four pile trestles some provision would have to be made whereby steamers would have access to the various granaries; but as steamers can only get up at high water, and as none of these steamers draw more than 4.5 feet loaded, I would suggest that the dike be built with its top 3.5 feet above mean-lower low water for its entire length.

A suitable dike could be built, I think, for $5 per linear foot, and as its length would be about 490 feet, the total cost in round numbers would be $2,500.

I believe that the balance of the appropriation of August 17, 1894, could be profitably expended in constructing this dike.

Very respectfully, your obedient servant,

E. L. CARPENTER.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Swinomish Slough is in the collection district of Puget Sound. The nearest port of entry is Port Townsend.

The following information relative to the commerce of Swinomish Slough, Washington, for the fiscal year ending June 30, 1895, was furnished by Mr. James Power, president of La Conner Chamber of Commerce.

Shipping.—The number of steam and sail vessels arriving at and departing from La Conner during the year was 950; their aggregate tonnage was about 115,000, and maximum draft loaded was 12 feet.

Only one or two vessels each week pass entirely through Swinomish Slough at present, and then only at full tide. The steam schooner *Maid of Oregon*, drawing about 10 feet of water, and a few others, known as "tramp steamers," are the only ones regularly passing through. Most of the other steamers and vessels entering the south end of Swinomish Slough are either bound for La Conner or the grain warehouses at the mouth of Telegraph Slough and intermediate points. Having discharged or taken on their cargoes, they return out the same way that they entered.

When the present project for dredging Swinomish Slough is fully completed, it is anticipated that the mail steamers will be enabled to pass entirely through at all stages of the tide.

No vessels were built here since date of last report except small fishing craft.

Exports and imports.

Articles.	Quantity.	Value.	Articles.	Quantity.	Value.
EXPORTS.			EXPORTS—continued.		
	Tons.			*Tons.*	
Logs (25,000,000 feet, B. M.)	50,000	$110,000	Cabbage seed	12	$8,520
Hops	185	37,000			
Hay	25,000	175,000	Total	109,167	1,110,520
Oats	32,000	592,000			
Fruits (small)	125	25,000	IMPORTS.		
Potatoes and other vegetables	400	4,000	General merchandise	5,750	402,500
Butter	50	15,000	Agricultural implements		
Cheese	5	1,000	Machinery, etc	(*)	150,000
Salmon (fresh)	1,000	100,000	Live stock	(*)	50,000
Live stock and meats	400	40,000			
Eggs (30,000 dozen)		3,000	Total	5,750	602,500

* Quantity unknown.

SUMMARY.

	Tons.	Estimated value.
Total exports	109,167	$1,110,520
Total imports	5,750	602,500

Of the industries at and in the vicinity of La Conner, that of salmon fishing is on the increase. The fish are caught and shipped to the canneries at Seattle and other points. The raising of cabbage seed is another important industry, largely on the increase, not less than 12 tons of the seed having been raised here during the past year and shipped, for the most part, to the large eastern seed establishments, where it is put up in packages and retailed. In commerce it is known as "Puget Sound cabbage seed."

Owing to the floods in certain districts last summer there was some decrease in farm products, but the prospects were never better than for the present season.

A well-equipped creamery has just been established at La Conner, and is now in working order. Its capacity has not yet been tested.

T T 21.

IMPROVEMENT OF PUGET SOUND AND ITS TRIBUTARY WATERS, WASHINGTON.

The old title of this appropriation was "Improvement of Skagit, Stillaguamish, Nooksack, Snohomish, and Snoqualmie rivers, Washington."

Under date of August 4, 1892, the change to the new title was approved and all money and property on hand were transferred and thereafter accounted for under the new title.

Description of original condition.—In their original condition the navigable streams flowing into Puget Sound carried water enough for the purpose of steamer navigation, but were obstructed by snags, fallen trees, and log jams. They were the great highways of the country, traveling by land being almost impossible on account of the heavy timber, dense underbrush, and fallen logs.

About their mouths there are in every instance large areas of shallow water with tortuous channels, and these are often obstructed by drift. These shallows act as submerged dams to the rivers and by preventing the free outflow of their waters indirectly do great damage by inundating the lowlands through which they flow.

Plan of improvement.—The plan of improvement contemplates the removal of snags, logs, trees, and other obstructions to navigation. For this purpose a snag boat with an outfit of tools and appliances has been provided. This boat passes from one river to another, doing service in each as far as the necessities of its commerce require and as the amount of the funds appropriated will admit.

With the funds that have been appropriated this snag boat and outfit have been provided and a large number of snags, jams, overhanging trees, and other obstructions to navigation removed. These, with the trees that from time to time fall into the rivers, will furnish constant employment for the snag boat for an indefinite period.

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1880	$2,500	September 19, 1890	$12,000
August 2, 1882	20,000	July 13, 1892	15,000
July 5, 1884	10,000	August 17, 1894	14,000
August 5, 1886	10,000		
August 11, 1888	15,000	Total	98,500

Amount expended to June 30, 1894.—The amount expended to June 30, 1894, was $82,048.18.

Results obtained to June 30, 1894.—In this class of work no permanent results are aimed at or obtained. The continually recurring snags, fallen trees, etc., require to be constantly removed. The rivers have been kept open for traffic and many of the perils of navigation have been removed.

Amount expended during fiscal year ending June 30, 1895.—The amount expended during the fiscal year ending June 30, 1895, was $5,775.28.

Results obtained during fiscal year ending June 30, 1895.—As shown more in detail in Captain Jefferson's report, a large amount of work was done in the principal rivers tributary to Puget Sound in removing snags and leaning trees, and navigation thereby was greatly benefited.

Report of operations.—In August, 1894, the snag boat *Skagit* was made ready for work and left Seattle for the Stillaguamish River August 24. Work was carried on here until August 29, when the boat left for the Skagit River. Work continued on the Skagit until October 21. Two days were spent in removing obstructions from Hat Slough and the boat then went to the Snohomish and Snoqualmie rivers, upon which work was carried on until November 10, when the *Skagit* returned to Seattle to lay up for the winter.

During the period of active operations there were 49 snags removed from the Stillaguamish River, 709 snags and 30 leaning trees from the Skagit River, and 140 snags and 57 leaning trees from the Snohomish and Snoqualmie rivers and Hat Slough.

The winter of 1894–95 being a very open one and the rivers in good condition for work, in February the snag boat was again fitted out and started to work in the Skagit River. Work progressed from the 13th to the 28th of February, when the main shaft of the snag boat gave out and it was necessary to cease operations and take the boat to Seattle for repairs.

During the period of active operations 144 snags were removed from the Skagit River.

After competition an informal contract was entered into with Moran Bros. Company for the necessary repairs to the boat. This work was completed May 18, 1895.

For the remainder of the fiscal year the boat was laid up in the fresh water of the Duwamish River.

Besides the active work of snagging plans and specifications for rebuilding the snag boat were carefully prepared.

Recommendations and remarks.—After planning for the rebuilding of the snag boat it was found that the money available would not do the work completely and leave anything for the care of the boat or for active work, and it was concluded to repair the boat as much as was absolutely necessary and then use the available funds for work which was badly needed and strenuously demanded by the navigation interests.

This was a matter of great regret, as the boat is in a dangerous condition and is really unfit for use.

There is an immense amount of work this boat could do if funds were available which would be of great value to people living on the rivers and to the interests of commerce generally. Most of the rivers flowing into Puget Sound have very flat slopes in the lower portion of their courses and divide into a number of delta mouths. All of these mouths are needed in an untrammeled condition to discharge the waters during freshet stages. In nearly every instance these mouths are to a greater or less extent blocked up by jams of drift and logs and obstructed so as to interfere with their use for purposes of navigation and to check the flow of the flood waters and cause the neighboring country to be inundated. In this manner great loss is entailed upon the country. These rivers also at their mouths flow over tide flats across which there are but narrow or crooked and shallow channels, the depth of which at low tide is much less than the depth of the river. These tide flats form permanent dams, preventing the free outflow of the rivers, and add to the causes producing disastrous inundations.

For the use of boats entering and leaving the rivers and the general good channels across these tide flats should be excavated leading into the main navigable channels and the delta mouths should be kept as free from obstructions as practicable.

The work done regularly with former appropriations in keeping troublesome snags out of the rivers has been of great value, but it has never gone far enough, and I recommend largely increased appropriations for the work. In the first place money should be provided to rebuild the snag boat *Skagit*.

The *Skagit* was built in 1882 and has had very hard usage ever since, and the time has now come when it is absolutely necessary to rebuild her. Her hull is rotten and weak and so water-logged that she draws too much water for use on the rivers during the periods in which she can be used to the best advantage. She is so water-logged and down by the stern that it is almost impossible to steer her.

She is now thirteen years old, which is more than the average life of Puget Sound fir when exposed to air and water.

The boat in going from river to river has to traverse the open waters of Puget Sound, and this in her present weak condition is dangerous. The machinery of the boat is good. Experience also demonstrates that certain changes and additions are needed to make the snag boat what it should be. For instance, she should be provided with a strong "spud" or "grouser" to hold her in place in a swift current, and she should have a force pump to enable the sand to be washed away from snags so that they can be taken hold of.

To rebuild the snag boat and make the necessary alterations and additions will cost, it is estimated, $15,000.

For actual work on the rivers an appropriation of $75,000 is recommended; in all, $90,000.

Future operations.—The snag boat will be kept at work whenever the rivers are in their best condition, in removing the worst snags.

Money statement.

July 1, 1894, balance unexpended	$2,451.82
Amount appropriated by act of August 17, 1894	14,000.00
	16,451.82
June 30, 1895, amount expended during fiscal year	5,775.28
July 1, 1895, balance unexpended	10,676.54
July 1, 1895, outstanding liabilities	160.00
July 1, 1895, balance available	10,516.54
Amount (estimated) required for completion of existing project	Indefinite.
Amount that can be profitably expended in fiscal year ending June 30, 1897	90,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

The report of Capt. E. H. Jefferson, who has had charge of the snag boat, is herewith.

Captain Jefferson gives such commercial statistics as he has been able to obtain.

Besides the work of snagging, Captain Jefferson has been the local representative of this office on the Sound, looking after all questions relating to bridges, obstructions, etc.

REPORT OF CAPTAIN E. H. JEFFERSON, MASTER OF SNAG BOAT.

SEATTLE, WASH., *May 20, 1895.*

SIR: I have the honor to submit the following annual report of operations of the U. S. snag boat *Skagit* at improvement of Puget Sound, Washington; also some commercial statistics of the various rivers in this district:

On August 20, 1894, after the regular season of summer floods, I commenced getting the boat ready for work at her moorings in the Duwamish River. On the 23d the boat was taken down the river to Seattle, where some slight repairs were made to the tackle and gear, and supplies taken on board.

On the evening of the 24th I left Seattle for the Stillaguamish River, arriving on the 25th and commencing work near the river's mouth. On the 29th departure was taken for the Skagit River, where operations were continued to and including October 21, removing obstructions from the channel from the mouth of the river up to a point called Nookchamps Creek, a distance of about 18 miles, about as far up as there appeared to be any immediate necessity of working.

On October 23 run over to Hat Slough, and worked part of two days removing from that waterway several complained of and dangerous channel obstructions.

On October 25 left Hat Slough for the Snohomish River, arriving and commencing work there on the same day. Work was prosecuted on this stream and its tributary, the Snoqualmie, to a point called Tolt River, about 40 miles up from salt water, till November 7, when the fall rains and consequent freshets caused too high water to do profitable snagging work for a period of several months.

On November 9 left the Snohomish River for Seattle, where the crew were discharged and the boat placed in winter quarters at her old moorings.

On February 13, 1895, commenced fitting out the boat again for service, and after making the usual preparations and taking on board supplies, left Seattle on the 16th for the Skagit River, where the stage of water was very favorable for effective work. Operations were continued on the Skagit River until and including the 27th, when the snag boat's main shaft showed evidence of breaking, rendering any further work impossible until repairs were made.

with a smaller one which has lately commenced making weekly trips to upriver points.

On the 28th left for Seattle, running slow, and when near to and in sight of the city the shaft gave out completely and the services of a tug were obtained to reach

a landing. After ascertaining that suitable material for a new shaft would have to be obtained from abroad, the boat was again laid up at the wharf of Moran Brothers' Company, and bids for furnishing a new shaft, rebuilding wheel, etc., were advertised for, and in due time the contract awarded to Moran Brothers' Company, the lowest bidders, who in course of time satisfactorily completed the repairs.

On May 18 the snag boat was taken to her fresh-water moorings in the Duwamish River, to remain till a favorable stage of water for profitable snagging work again occurred.

During the seasons accounted for above many difficult and dangerous obstructions were removed from the channels of the various navigable streams of this district; some of them being huge spruce and fir stumps that more than taxed the lifting capacity of the boat's gear and necessitated a liberal use of giant powder to successfully remove them.

These giant stumps are often as much as 8 and 9 feet across the tops, with trunks of 10 to 12 feet, and a spread of large roots of from 20 to 30 feet. They are constantly being washed from the banks by the currents at times of freshets and deposited in the channel, where they at times set up as straight as they did in their native soil. In time their roots become embedded in the gravel and sand of the river's bottom, thus causing very dangerous obstructions.

The hull of the snag boat is becoming very rotten, water-soaked, and weak, and will not stand much more service without some very extensive repairs being made. The frames are so rotten that there is nothing to nail to on her sides. The cylinder timbers are getting weak and will have to be renewed, as it is now difficult to keep the engines in line. New strengthening knees and timbers and steps for hog posts are needed, and if repairs are attempted they will no doubt cost about as much as a new hull, for when you once commence to tear down an old boat you never know where to stop, and in the end it costs about as much as a new hull could be built for. I recommend that a new hull be built as soon as money can be made available for the purpose. The machinery, hog chains, etc., are all good and can all be used again with the exception of perhaps some of the inexpensive pipe fittings. The old hull is getting more and more out of shape and "hogged," which makes her difficult to handle and manage in close and difficult places.

If a new hull is built several important improvements could be made which would be very effective in snagging work, as noted in my last annual report.

Following is a summary of the snag boat's operations for the periods stated:

Snags and drift removed:		
Skagit River		853
Stillaguamish River		49
Hat Slough		15
Snohomish and Snoqualmie rivers		125
Total		1,042
Largest diameter	feet	12
Smallest	inches	6
Total length	feet	30,526
Leaning trees chopped from banks:		
Skagit River		30
Snoqualmie River		57
Total		87
Largest diameter	feet	10½
Smallest diameter	inches	6
Total length	feet	4,998

Additional operations consisted of the usual amount of work required to keep the boat and her tackle and gear in working order, which was usually done at times of freshets or high winds when snagging could not be profitably engaged in.

The dull times and the results of last year's exceptionally high floods have had a depressing effect on the business done by the steamers engaged on some of the rivers in this district, but still the streams need annual snagging or they would soon become unnavigable by reason of the accumulation of snags and drift.

The work of the snag boat is of great benefit to the navigable interests of the rivers, and could hardly be dispensed with.

On the Skagit River route, which includes the Stillaguamish River, there is but one regular steamer running at present up as far as Mount Vernon, where it connects

On the Snohomish River from Seattle there are at present two regular steamers engaged, and on the Snoqualmie, its tributary, from the town of Snohomish up to

the head of navigation, two small boats are regularly employed when business warrants and the stage of water permits.

One steamer is also regularly employed towing logs from the Snohomish down to salt water except when the stage of water is too low for towing.

Between Everett and Snohomish, via Lowell, one small passenger steamer makes three trips daily and carries a large number of passengers.

Between Seattle and Everett there is one passenger steamer engaged (and sometimes two) in making three round trips per day during the summer days; it does a large passenger business and carries some small freight.

On the Nooksack River there is no steamer plying at present, as that stream's entrance is blocked by the works of the Bellingham Bay Boom Company, and the drift and sand bars caused by it, a suit against whom is now pending in the United States courts.

On the Duwamish River there are no regular boats engaged, but a large quantity of hay and other farm produce are annually freighted from this and other rivers and sloughs by jobbing boats at irregular times.

No accurate commercial statistics of these rivers can be obtained from the fact that the different steamboat owners doing business thereon only keep a record of their business in dollars and cents.

The following figures are submitted as representing the business done by the *regular* steamboats on the different rivers in this district at the present time, and which it is believed would be a fair average for the past year.

Number of tons and passengers given represent the business done monthly:

Route.	Freight.	Passengers.
	Tons.	*Number.*
Skagit River, via Stillaguamish	1,500	820
Snohomish River	600	200
Snoqualmie River	220	175
Between Everett and Snohomish, via Lowell	20	2,200
Between Seattle and Everett	60	2,300

Freight handled by these steamers consists of general merchandise on up trips, and hay, hops, grain, and other farm products, also paper and nails manufactured at the mills at Everett and Lowell on the return trips, but the greater portion of the two last-named articles is carried by irregular boats which occasionally go to these mills for a full load.

Considerable freighting of manufactured lumber and building material, also of machinery, is done on all these rivers and tidal sloughs by lighters and small tugs, an account of which it is next to impossible to obtain a record of.

Thinking it might not be out of place, I append to the above report the following figures representing the business of the Puget Sound customs district, output of coal, umber shipments, etc., for the year 1894:

	Number.	Tonnage.
Vessels entered	1,484	1,234,002
Vessels cleared	1,580	1,533,857

Value of foreign goods passing through Puget Sound customs district destined for American cities	$4,971,134
Value passing through for foreign ports	488,550

	Quantity.	Value.
Lumber shipments to foreign ports, feet	86,174,790	$769,190
Lumber shipments to foreign ports, 1892, do	112,754,000	1,133,727
Wheat exports, bushels	4,289,994	2,089,223
Flour exports, barrels	295,907	726,021

Receipts of custom-house from all sources	$260,628.40
Value of imports for the State	1,525,917.00
Value of exports for the State	5,247,288.00
Output of coal from mines in King County, tons	437,939

Very respectfully, your obedient servant,

E. H. JEFFERSON,
Master of Snag Boat.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

T T 22.

PRELIMINARY EXAMINATION OF UMPQUA RIVER, OREGON, FROM SCOTTSBURG TO ELKTON RAPIDS.

[Printed in House Ex. Doc. No. 229, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington D. C., January 19, 1895.

SIR: I have the honor to submit the accompanying copy of report dated January 1, 1895, by Capt. T. W. Symons, Corps of Engineers, of the results of a preliminary examination of Umpqua River, Oregon, from Scottsburg to Elkton Rapids, made in accordance with the provisions of the river and harbor act of August 17, 1894.

In the opinion of Captain Symons, this portion of the Umpqua River is not worthy of improvement by the General Government, and this opinion is concurred in by Col. G. H. Mendell, Corps of Engineers, the division engineer, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report of the preliminary examination of the Umpqua River, Oregon, required at my hands by the terms of your letter of August 20, 1894:

> The examination of the river is required from Scottsburg to Elkton Rapids.

It is my opinion that this portion of the Umpqua River is not worthy of being improved by the General Government, because of the great cost of the necessary work required, the small local interests involved, and the dearth of any particular public interest in the work.

The Umpqua is the largest river of southern Oregon, having its sources in the Cascade Mountains. Its two main branches unite just below Roseburg, and it then flows swiftly in a rocky channel through a narrow and precipitous valley to the sea.

The entrance to the river from the sea is one of the best along the Oregon coast, and the river itself is navigable for small steamers as far as Scottsburg, 25 miles from the mouth. Scottsburg is practically the head of tide. Just above the town are some rocky rapids. From this point up to Elkton the river generally flows with a very swift current, with alternating pools and rapids. At low water the navigation of the river is entirely impracticable on account of lack of water, and as the river rises the current increases in rapidity to such a degree as to preclude any practicable and profitable navigation.

The bed of the river is generally of rock, and the average slope is so great that it is entirely out of the question to improve the river by regularizing it to convert it into a navigable stream. The only method by which the river can ever be converted into a watery commercial

highway would be by putting in a series of locks and dams, of which there would have to be a large but undetermined number, between Scottsburg and Elkton Rapids.

The valley of the Umpqua between Elkton and Scottsburg is very narrow; the arable land along it does not average more than a half mile in width. Hills more or less timbered rise abruptly on both sides.

At Elkton the Umpqua receives the waters of a considerable tributary, Elk Creek, and upon this, and the main river above Elkton, are small valleys and settlements. A wagon road runs up Elk Creek to Drains Station on the Oregon-California Railroad, a distance of 17 miles. The old Scottsburg wagon road runs up the main river to Roseburg.

Historical.—In the early days, when the settlement of Oregon was taking place, at the mouth of the Umpqua was located the principal entrepôt for the Upper Umpqua and Rogue River valleys. Merchandise and supplies were brought into the river by ocean-going craft, taken to Scottsburg by smaller river craft, and thence out into the upper valleys by a wagon road located along the Umpqua River.

So difficult and expensive was this wagon transportation that relief was sought in the navigation of the river, and a small steamer was built which made one trip at a suitably high stage of water from Scottsburg to Roseburg. The difficulties, expense, and risk of the trip were, however, found to be so great that the idea of navigating the river in its then condition was abandoned.

Relief was sought from the Government, and in 1871 an appropriation of $22,500 for the improvement of the river was made. With this money a large amount of work was done, but experience and observation during the progress of the operations convinced Maj. H. M. Robert, who had the work in charge, that it was impossible by regularization to put the river into a condition sufficiently good to permit water navigation to successfully compete with wagon transportation.

Besides this, the Oregon-California Railroad was being extended from Portland to Roseburg, and this would enable the valleys of Southern Oregon to be supplied by rail much cheaper and better than they could be supplied by the route down the Umpqua, either by wagon or steamboat.

Of the $22,500 appropriated, all but $4,685.89 was expended when the work was definitely abandoned.

The supply route via the Umpqua River and the ocean has been entirely abandoned. A stage carrying mail and passengers makes three trips a week over the road between Elkton and Scottsburg. Other than this the interests on the route are slight and of a local nature only.

The very great and rapid fluctuations of the river and the rapidity of the currents would render lock and dam construction very costly.

Very respectfully, your obedient servent,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 7, 1895.

Respectfully forwarded.

The Umpqua River, between Scottsburg and Elkton Rapids, is regarded as not worthy of improvement by the General Government, owing to the excessive cost of any effective improvement and the small advantage that would thereby be secured.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

T T 23.

PRELIMINARY EXAMINATION OF YAQUINA BAY, OREGON, FOR INCREASED DEPTH.

[Printed in House Ex. Doc. No. 227, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1895.

SIR: I have the honor to submit the accompanying copy of a report, dated January 1, 1895, by Capt. T. W. Symons, Corps of Engineers, upon a preliminary examination of Yaquina Bay, Oregon, for increased depth, made in accordance with the requirements of the river and harbor act of August 17, 1894.

It is the opinion of Captain Symons and of Col. G. H. Mendell, Corps of Engineers, the division engineer, that this locality is not worthy of further improvement by the General Government, and in this opinion I concur.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report on the preliminary examination of "Yaquina Bay Bar, Oregon, for increased depth," required by the act of August 17, 1894, and your letter of August 20, 1894.

It is my opinion that Yaquina Bay Bar is not worthy of further improvement by the General Government for the following reasons:

The entrance to Yaquina Bay has been under improvement by the General Government for fourteen years, the first appropriation for the work having been made June 14, 1880.

The work continued and was carefully studied by the officers and assistants in charge until 1888, when a Board of experienced engineers was appointed to consider what had been done and to perfect plans for further work. This Board met and carefully examined the situation,

and with all the light of past experience here and elsewhere formulated a plan for the completion of the improvement, which plan was intended by them to give Yaquina the best entrance possibly attainable under the existing natural conditions and prevailing physical phenomena.

This plan is now practically completed; when a small amount of stone has been added it will be fully finished.

The work has been eminently successful; the improvement of the bar has been all or more than the Board hoped would be accomplished. From an uncertain bar channel of about 7 feet at low water, varying greatly in position, there is now a permanently located bar channel of 12 to 14 feet depth at low water.

After an intimate acquaintance with Yaquina Bay, having had charge of the works there for five years, I am unable at the present time to devise or recommend any modification or extension of the plan of improvement as now practically completed which would give any marked or appreciable increase of depth on Yaquina Bay Bar, and for this reason I deem it unworthy of further improvement.

The depth which can be obtained and maintained upon the bar of a harbor like Yaquina Bay is mainly dependent upon the amount of tide water flowing in and out and the velocity, direction, and concentration of its flow. The tidal volume is practically independent of any efforts of man as far as increasing it goes; all he can do is to give direction and concentration to its flow, so as to produce the maximum scouring effect upon the bar.

This has been done at Yaquina Bay. The two jetties built to above high tide direct the ebbing and flooding waters perpendicularly upon the bar in a channel having a minimum width between the jetties of about 900 feet. Any further contraction of the width between the jetties to increase the velocity of the waters and consequent scouring effect on the bar would be dangerous to the structures themselves. Already, with a thousand feet between the jetties, it has been found necessary to protect the south jetty with groins.

To extend the jetties farther would do very little good, as it would not materially change the co-relations existing between the tidal volume of the bay, the velocity of flow of the waters, the moving sands, and the winds and waves of the ocean.

The depth which can be maintained on a bar like that at Yaquina is also dependent upon the magnitude of the wave action to which it is exposed. The greater the wave action the less the depth which can be looked for permanently in the bar channel.

There is an outer reef of rocks off Yaquina Bay which has undoubtedly a powerful effect in sheltering the bar and the entrance against the heaviest waves and in permitting the bar channel to maintain itself at a greater depth than would otherwise be possible.

The existence of this reef is one of the circumstances which has rendered the work at Yaquina Bay so successful. The bar now lies about midway between the ends of the jetties and the reef.

To extend the jetties would not only be productive of little good, as before stated, but it is believed that any extension which would throw the bar beyond the protection of the outlying reef would be productive of evil and tend to diminish the permanent depth of the bar channel.

It might be at first sight considered that at Yaquina Bay, as at some other harbors, an increased depth on the bar could be obtained and maintained by dredging, but a knowledge of the local conditions and of the phenomena of the moving sands indicates beyond the shadow of a doubt that such a method is entirely inapplicable there. The

sands move so freely and in such vast quantities that all the dredging that could be done in months would be entirely undone in a few hours by the action of storm waves upon the surrounding sands. It may be stated with the greatest certainty that dredging is entirely out of the question.

Yaquina Bay is now a very good harbor for coasting vessels drawing 10 to 15 feet of water. Vessels drawing 9 or 10 feet can enter and leave at any stage of the tide. Vessels drawing up to 12 or 13 feet enter and leave freely at the higher stages of the tide, and with quiet weather and a high tide vessels drawing as much as 15 feet could safely enter or depart.

In my opinion it is beyond the power of man to make it into a harbor of sufficient capacity for deep-draft ships engaged in foreign commerce, or in fact to give this entrance a bar channel depth appreciably greater than that now existing.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded.

The improvement already accomplished is regarded as very successful. It has increased the bar depth at low water from about 7 feet to 13 or 14 feet.

Further improvement would be attempted by prolonging the jetties seaward, with the view of throwing the bar farther out in deeper water.

As pointed out in this report, the bar may thus be thrown outside of the shelter of the outlying reef, with the chance of injuring the entrance.

On the other hand, there is no assurance that extension of the jetties will assure increased depth.

This improvement is not regarded as worthy to be undertaken by the General Government.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

T T 24.

PRELIMINARY EXAMINATION OF QUILLAYUTE HARBOR AND RIVER, WASHINGTON.

[Printed in House Ex. Doc. No. 230, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated January 1, 1895, with map,* by Capt. Thos. W. Symons, Corps of Engineers, upon preliminary examination of Quillayute Harbor and

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* Omitted. Printed in House Ex. Doc. No. 230, Fifty-third Congress, third session.

River, Washington, made in compliance with requirements of the river and harbor act of August 17, 1894.

Captain Symons reports that in his opinion the river and harbor are worthy of improvement to the extent of closing the existing entrance and opening the former entrance of the river into Quillayute Harbor. Col. G. H. Mendell, Corps of Engineers, the division engineer, reports that Quillayute Harbor is regarded as worthy of improvement by the General Government.

I concur in the views expressed by these officers.

It is estimated that it will cost $200 to make the requisite survey and prepare plans and estimate for the work of improvement.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report of the preliminary examination of Quillayute Harbor and River, Washington, required from me by the terms of your letter of August 20, 1894:

It is my opinion that Quillayute Harbor and River are worthy of improvement by the General Government to the extent hereinafter mentioned.

Quillayute Harbor is in, probably, the most remote and inaccessible region of the United States. It lies in the northwestern portion of the State of Washington, connecting with the Pacific Ocean about 35 miles to the south of Cape Flattery. It is separated from the centers of population on Puget Sound by the extremely rugged and unexplored Olympic Mountains.

The Quillayute River is about 5 miles long, and the distance from its mouth to the head of tide is 2½ miles. It is fordable at ordinary stages and low tide 1½ miles from its mouth. Below this it gets deeper and in the lower half mile it has depths of 10 to 15 feet at low tide. The nontidal portion of the river is about 350 feet wide, with depths of 4 to 5 feet, but it is so obstructed with rapids that it can only be navigated by canoes.

The tributary rivers which make up the Quillayute are shallow streams, navigable for canoes for 20 to 30 miles. The average range of tide at the mouth is about 8 feet.

The valleys of these streams have been settled by a number of hardy pioneers, who are engaged in stock raising and general farming. There are about 500 white people altogether in the valley of the Quillayute.

The river just before reaching the ocean widens out into a small bay or tidal basin. This, at high tide, is about 800 feet wide and 4,000 feet long. It is separated from the ocean by a low sand tongue. The entrance channel is at the northern end of this sand tongue, and is about 150 feet wide and at the throat is about 10 to 12 feet deep. It opens out into a shallow bay studded with concealed rocks, which are so dangerous as to render the bay practically unnavigable.

A map of the mouth of the river is herewith which shows the general situation, but which gives no intimation of the hidden dangers outside of the mouth of the river.

The river formerly opened out to the south, into what is marked Quillayute Harbor. This harbor is, as far as known, free from dangerous rocks and is pretty well sheltered from the northwest winds of summer.

A log jam in the old mouth caused it to shoal up and the present mouth to open eighteen years ago.

The improvement desired is that the former condition of affairs be restored. Under former conditions when the river debouched into Quillayute Harbor at the point A on the map, it could be entered by vessels drawing 10 feet.

It is my opinion that the river and harbor are worthy of improvement to the extent of closing the existing entrance and opening the former entrance into Quillayute Harbor.

This is apparently the only outlet through which the valley of the Quillayute can hope to attain a reasonably cheap communication with the markets of the world. At present the cost of getting supplies in is very high, and the cost of getting products out is practically prohibitive.

Communication must now be by a pack trail 46 miles long from Clallam Bay, over which supplies are carried to the upper portions of the valley. A small steamer occasionally goes to Quillayute Harbor, and supplies are taken ashore in Indian canoes, and by this means the lower valley is supplied.

If the entrance were changed as suggested, the same steamer or others could enter the river and discharge and load at wharves, and the cost of transportation would be lessened, and a decided impetus given to the settlement and development of a fine region of country, and its great natural resources of timber would become available.

To make the requisite survey and prepare plans and estimate for the improvement, it is estimated, will cost $200.

For further information attention is invited to the report of Lieut. F. R. Shunk, Corps of Engineers, herewith.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded.

For reasons stated in these reports, Quillayute Harbor is regarded as worthy of improvement by the General Government.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF FIRST LIEUT. FRANCIS R. SHUNK, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., October 5, 1894.

SIR: I have the honor to submit the following report of an examination made by me of Quillayute River and Harbor, September 11–19, 1894:

The Quillayute River is in the northwestern portion of the State of Washington, and empties into the Pacific Ocean about 35 miles south of Cape Flattery.

The river properly so called is only 5 miles long. Its general course is westerly It has four principal tributaries, direct or indirect, the Dickodochtedar, Solduk, Calower, and Bogechiel. The Quillayute is formed by the union of the Bogechiel and Solduk, 5 miles above the ocean. Seven miles above this junction, the Bogechiel is joined by the Calower, and the Dickodochtedar flows into the Quillayute half a mile above its mouth. The name Quillayute is sometimes extended to the Bogechiel. The spelling of all these names is variable.

These tributary rivers rise among the Olympic Mountains, and in their upper courses are rapid mountain streams flowing through canyons or narrow valleys. The valleys widen out, and at length coalesce, forming a plain of considerable extent.

In its nontidal portion the Quillayute is about 350 feet wide and 4 or 5 feet deep. It is, however, obstructed by several rapids, so that it is navigable only for canoes. The head of tide is 2½ miles above the mouth. A mile and a half above the mouth the river is fordable at ordinary stages and low tide. Below this, the width and depth increases, and the lower half mile or so has a depth of 10 to 15 feet at low tide. The average range of tide at the mouth is about 8 feet. The tributary rivers are shallow streams, navigable for canoes for considerable distances, the Bogechiel for 30 miles, the Solduk for 20 miles, the Dickodochtedar for 18 miles. The banks of these rivers in their lower portions, and of the Quillayute, are low and overflowed during high stages. There are two high-water seasons each year, in the spring and in the autumn. The highest water is usually in November, and in the plain is 10 feet above the ordinary summer stage. In the canyons it is much higher. The Solduk and Bogechiel rivers are said to rise within a short distance of each other almost due south of Port Angeles. This would make these streams considerably longer than they are represented on the map. The total drainage area of the Quillayute is approximately 700 square miles. The area of the valleys and the plain is about 150 square miles; but much of the hilly country would be excellent for grazing, and probably half of the total area is good for agricultural purposes. With the exception of a number of fern prairies in the plain, whose total area is about 4,000 acres, and a comparatively small area of cleared land, the whole country is covered with very fine spruce, fir, and cedar timber. The land when cleared is very fertile, especially in the river bottoms. The population of the country is about 500 whites and 234 Indians. The latter, the Quile-ute tribe, of the Chimakuan stock, are settled at the mouth of the Quillayute, in a village called Lapush, a corruption of La Bouche. They are engaged in fishing, whaling, and sealing, and supply a good many furs to the Washington Fur Company, which has a station and general store at Lapush. There is no other settlement in the country. The white people are scattered on ranches, engaged in stock raising and general farming. There are half a dozen post-offices along the trail from Clallam to Lapush, and general stores at Boston, 2½ miles; Tyee, 22 miles; and Beaver, 26 miles above Lapush.

A map of the river mouth and coast adjacent is submitted herewith. The river formerly emptied into the lower bay, marked Quillayute Harbor at the point A. It could then be entered by vessels drawing 10 feet, and was visited by schooners in the fur trade. The harbor is fairly sheltered from the northwest winds of summer. The water is 3 to 4 fathoms deep within 100 yards of the shore. It is, however, only sheltered slightly from the south by the reef of rocks shown, which break the seas somewhat, and is open to the southwest so that it is almost useless in winter.

Its width is three-quarters of a mile, and its depth about half a mile. The southern point is a rocky and precipitous cape. From this cape the highland recedes toward the interier, leaving almost 2 miles of comparatively low coast as far as the new mouth to the Quillayute. The northern limit of the harbor is a group of four high rocky islets, the largest of which, James Island, has an area of 18 acres. Three of these islets are within the low-water line.

The coast in this vicinity is rocky and dangerous. There is no shelter to speak of between Grays Harbor and Cape Flattery. The nearest lighthouses are Destruction Island, 18 miles south, and Tatoosh Island, 35 miles north.

In the spring of 1876 a log jam at the old mouth caused the river to break through the north end of the sand spit into the upper bay. This bay is exposed, and so studded with concealed rocks that vessels are afraid to enter. An Indian named Captain Socks owns a 10-ton sloop, the *Dart*, which he occasionally takes in and out through a tortuous channel, but no one else will attempt it. The present mouth is 150 feet wide and 10 to 12 feet deep. It is sometimes wider and shallower. The old course of the river, south of the present mouth, is marked by a slough about half a mile long. This has filled up to some extent in its upper part, but there is still a channel 10 feet deep at low tide. Between the lower end of this slough and Quillayute Harbor, there is a low sandy isthmus about 150 yards wide. The inhabitants wish the river to be returned to its former position.

The vital question for the Quillayute country is that of communications. The valley is separated from the Strait of Fuca by a range of hills, a spur of the Olympic Mountains. A trail, about 46 miles long, leads from Clallam Bay, on the straits, to

Lapush. Some of the grades on this trail are very steep, and transportation is entirely by pack horse. A pack train leaves Clallam for Beaver, 20 miles, two or three times a week. The minimum rate for this distance is $20 per ton. Beyond Beaver, supplies are usually obtained from Lapush at about the same rates. The steamer *Willapa* makes three trips a week between Seattle and Neah Bay, stopping at Clallam. The rate from Seattle to Clallam is $5 per ton. About once in six weeks, the weather permitting, the *Willapa* rounds Cape Flattery and goes to Quillayute Harbor. Freight is then taken ashore by the Indian canoes. The rate from Seattle is $10 per ton, $7 for the store. The *Willapa* could enter the river if the old mouth was open.

The schooner *Teaser*, of Seattle, 45 tons burden, belonging to the Washington Fur Company, occasionally visits the harbor with supplies for the store.

It is said that the steamer *Farallon*, plying between San Francisco and Seattle, will soon stop three times a month at Clallam, and that she will carry freight to and from Seattle for $3 per ton. Sailing vessels which carry timber from the Clallam mill to San Francisco sometimes bring back supplies at $1.50 per ton.

These high rates make living expensive and export unprofitable, and completely prevent the development of the country. The people look for relief to the opening of the river mouth. Near the mouth of the Quillayute is an exceptionally fine site for a lumber mill if there were any means of export. The slough B is a natural receiving pocket, and the various tributary streams aggregate 200 miles of good driving water through the best of timber country. If vessels could enter the river, it is believed that a mill would speedily be built, and that schooners running to San Francisco would bring back supplies at reasonable rates. The country could then scarcely fail to be rapidly settled and developed, its fertility and resources being well known.

For the reasons indicated above, it is my opinion that the Quillayute River is worthy of improvement to the extent of closing the present and opening the old mouth of the river. I think that no survey is needed to estimate the cost. Should one be deemed necessary, it would cost not more than $200.

Very respectfully, your obedient servant,

FRANCIS R. SHUNK,
First Lieutenant, Corps of Engineers.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

T T 25.

PRELIMINARY EXAMINATION OF CLALLAM BAY, WASHINGTON, WITH A VIEW TO ITS IMPROVEMENT AS A HARBOR OF REFUGE.

[Printed in House Ex. Doc. No. 226, Fifty third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 1, 1895, with map,* by Capt. Thomas W. Symons, Corps of Engineers, upon the preliminary examination of Clallam Bay, Washington, "with a view to its improvement as a harbor of refuge," made to comply with the requirements of the river and harbor act of August 17, 1894.

It is the opinion of Captain Symons that Clallam Bay is not worthy of improvement by the General Government with the end in view of converting it into a harbor of refuge.

Col. G. H. Mendell, Corps of Engineers, the division engineer, reports that the improvement required to make Clallam Bay a harbor of refuge is not regarded as worthy to be undertaken by the General Government.

I concur in the views expressed by these officers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen. Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

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*Omitted. Printed in House Ex. Doc. No. 226, Fifty-third Congress, third session.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report of the preliminary examination required from me by your letter of August 20, 1894, of "Clallam Bay, Washington, with a view to its improvement as a harbor of refuge."

Clallam Bay is a shallow indentation on the southern shore of the Straits of Juan de Fuca, 24 miles to the east of Cape Flattery.

The Straits of Fuca at this point is 13 miles wide, and the general depth of water is from 40 to 100 fathoms. Clallam Bay is 2 miles in length and 1 mile in width back from the headlands. It is open broadside to the straits. In depth it slopes gradually and quite regularly from the shore to a depth of 10 fathoms at a distance of about 3,000 feet from shore. One mile from shore the depth is 40 fathoms. It is well sheltered from the south, east, and west, but fully open to the north.

A map is herewith, showing the Straits of Fuca, and on the same is a chart of Clallam Bay on a larger scale. Lieutenant Shunk's report, which is herewith, gives a description of the physical and other features of the bay and vicinity.

In order to arrive at a correct determination as to the propriety of improving Clallam Bay as a harbor of refuge, a general investigation has been made concerning the commerce passing through the Strait of Fuca, the dangers besetting it, the prevailing physical phenomena, etc.

Commerce.—The Straits of Fuca is the passage through which all the commerce of the great bodies of water known as Puget Sound and the Gulf of Georgia connects with the Pacific Ocean. From Cape Flattery Light to New Dungeness Light the straits are 76 statute miles in length and about 13 miles in width. The foreign and domestic commerce passing through the straits is very great. Besides the exports of coal and lumber, which are enormous in aggregate amount, and the local supplies brought in by water, the Straits of Fuca serves to connect the highway of the ocean with three transcontinental railroads reaching the Atlantic Seaboard—the Northern Pacific, the Great Northern, and the Canadian Pacific.

To illustrate the magnitude of the commerce passing through the straits, I give here a table of the arrivals and departures for the two years ending June 30, 1894, to and from United States ports. This list was furnished me through the kindness of Mr. J. C. Saunders, collector of customs at Port Townsend.

I have not obtained similar information as to the amount of tonnage going to and from the British ports of Victoria, Vancouver, Nanaimo, New Westminster, etc., but it is probably nearly as great in amount as that of the ports of the United States.

UNITED STATES CUSTOM-HOUSE,
Port Townsend, Wash.

Clearances and entrances July 1, 1892, to June 30, 1894.

CLEARANCES.

Month.	Number of steam vessels.	Number of sailing vessels.	Hailing from foreign ports.	Hailing from domestic ports.	Total number clearing	Tonnage, foreign.	Tonnage, domestic.	Total tonnage cleared.
1892.								
July	111	23	110	24	134	80,351	26,748	107,099
August	118	22	112	28	140	75,858	30,614	106,472
September	118	23	120	21	141	90,938	22,032	112,970
October	109	27	117	19	136	86,544	22,572	109,116
November	120	35	138	17	155	99,663	18,863	118,526
December	96	23	103	16	119	75,991	18,557	94,548
1893.								
January	93	17	96	14	110	68,977	17,020	85,997
February	65	15	68	12	80	59,100	11,917	71,017
March	102	26	112	16	128	69,148	14,612	83,760
April	101	19	103	17	120	58,356	18,442	76,798
May	132	24	136	20	156	79,410	20,319	99,729
June	117	8	109	16	125	78,610	22,586	101,196
July	139	13	137	15	152	87,676	18,203	105,879
August	123	16	124	15	139	78,212	17,462	95,674
September	106	27	115	18	133	78,768	21,787	100,555
October	108	23	114	17	131	76,083	16,230	92,313
November	109	25	120	14	134	85,155	16,900	102,055
December	93	26	101	18	119	71,891	16,316	88,207
1894.								
January	81	15	84	12	96	58,652	14,088	72,740
February	70	14	73	11	84	60,966	14,614	75,580
March	102	21	109	14	123	72,688	14,754	87,442
April	118	20	120	18	138	75,390	17,546	92,936
May	130	22	136	16	152	80,766	16,031	96,797
June	145	17	145	17	161	76,510	16,669	93,179
Grand total	2,606	501	2,702	405	3,106	1,825,703	444,882	2,270,585

SUMMARY.

Total for last six months, 1892	672	153	700	125	825	509,345	139,386	648,731
Total for first six months, 1893	610	109	624	95	719	413,601	104,896	518,497
Total for last six months, 1893	678	130	711	97	808	477,785	106,898	584,683
Total for first six months, 1894	646	109	667	88	754	424,972	93,702	518,674
Grand total for two years	2,606	501	2,702	405	3,106	1,825,703	444,882	2,270,585

ENTRANCES.

1892.								
July	112	21	108	25	133	75,274	31,332	106,606
August	109	24	102	31	133	69,446	32,443	101,889
September	119	23	112	30	142	81,678	33,592	115,270
October	115	26	108	33	141	78,190	38,249	116,439
November	117	23	111	29	140	74,854	30,914	105,768
December	94	17	92	19	111	58,682	23,687	82,369
1893.								
January	106	14	98	22	120	61,643	29,303	90,946
February	69	14	65	18	83	51,577	22,461	74,038
March	93	19	88	24	112	49,564	26,918	76,482
April	125	12	115	22	137	54,686	25,870	80,556
May	116	12	109	19	128	59,832	20,547	80,379
June	106	10	93	23	116	60,949	29,310	90,259
July	142	16	134	24	158	82,181	27,247	109,428
August	120	16	117	19	136	70,849	27,334	98,183
September	104	23	101	26	127	65,111	25,392	90,503
October	107	16	102	21	123	71,223	19,143	90,366
November	104	11	99	16	115	63,469	17,522	80,991
December	91	19	93	17	110	65,391	21,279	86,670

Clearances and entrances July 1, 1892, to June 30, 1894—Continued.

ENTRANCES—Continued.

Month.	Number of steam vessels.	Number of sailing vessels.	Hailing from foreign ports.	Hailing from domestic ports.	Total number clearing.	Tonnage, foreign.	Tonnage, domestic.	Total tonnage cleared.
1894.								
January	85	15	86	14	100	60,476	21,280	81,756
February	68	4	60	12	72	42,091	19,495	61,586
March	98	16	94	20	114	58,788	28,484	87,272
April	113	17	113	17	130	66,785	19,409	86,194
May	123	20	125	18	143	68,960	21,637	90,597
June	146	19	143	22	165	73,946	23,620	97,566
Grand total	2,582	407	2,468	521	2,989	1,565,645	616,468	2,182,113

SUMMARY.

Total for last six months, 1892	666	134	633	167	800	438,124	190,217	628,341
Total for first six months, 1893	615	81	568	128	696	338,251	154,409	492,660
Total for last six months, 1893	668	101	646	123	769	418,224	137,917	556,141
Total for first six months, 1894	633	91	621	103	724	371,046	133,925	504,971
Grand total for two years	2,582	407	2,468	521	2,989	1,565,645	616,468	2,182,113

This table, summarized, shows that there are on the average, monthly departures from ports of the United States of 130 steam and sail vessels with a monthly tonnage of 95,000 tons, and monthly arrivals of 125 steam and sail vessels with a monthly tonnage of 91,000 tons.

This aggregate would be about doubled by the addition of the arrivals and departures at and from British ports.

Dangers besetting commerce.—Throughout the Straits of Fuca there is an abundant depth of water and very few dangers in the way of rocks isolated from the shore.

The real dangers which beset vessels come from thick weather, fog, rain, and smoke, which are very prevalent; winds, the set and strength of the heavy cross seas off the entrance, which departing vessels must encounter or return some 50 miles to a place of safety, and the lack of anchorage and sheltered positions to which to retire in case of storm or trouble.

Rain, fog, smoke.—About the entrance to the straits the rainfall is very great; at Neah Bay it averages about 100 inches per year, while it has been known to rain 132 inches in a single year.

At Port Townsend and Victoria, at the eastern end of the straits, the rainfall is only about 20 inches per year.

When not raining about the entrance it is apt to be very foggy, the foggiest months being July, August, and September. The fogs are densest near the entrance and decrease in frequency and intensity toward the inner end of the straits.

Added to the rain and fog is a dense smoke which hangs over the country, often for considerable periods. This comes from forest fires and clearing fires about the straits and sound.

This prevalence of thick weather indicates the desirability and necessity of a multiplicity of guiding signals along the shore of the straits.

Winds.—During the summer but little trouble is experienced from the winds, but in winter the strong southeast winds draw directly out and create a very heavy cross sea off the entrance, the great southwest swell meeting that going out.

In such cases sailing vessels going out to sea are in great peril. The alternative is to put back to Port Angeles or Royal Roads, some 50

miles, and wait for a change of wind. Neah Bay is also sometimes used by vessels in which to ride out rough weather. Clallam Bay is also occasionally used for this purpose.

Currents.—The currents run through the straits with great velocity, the average being about 3 miles per hour. Off the Race Rocks and Beechy Head it often reaches 6 miles per hour.

There is a peculiar set to the currents which, combined with the prevailing heavy swells and the southwest winds of winter, make it dangerous to get near the northern shore of the straits about the entrance. If a ship near the entrance gets beyond control, she is almost certain, unless rescued, to bring up on the shores of Vancouver Island.

Anchorage.—The water in the Straits of Fuca is of great average depth. In some places bottom was not found with a 150-fathom line. The deep water continues close up to shore as a general thing. The only anchorage on the south shore of the straits near the entrance is in Neah Bay. This anchorage is very imperfect on account of the bay being open to the swells to the north and east, and because of the strong currents through it.

The next anchorage is at Clallam Bay, which is 24 miles inside Cape Flattery. This anchorage is entirely open to the north, but, as before stated, is protected from the south and to a limited degree from the east and west.

The next anchorage is a similarly situated bay, called Freshwater Bay, about 55 miles in from Cape Flattery. The nearest well protected anchorage to the entrance to the straits is Port Angeles, 65 miles from Flattery.

There is manifestly great danger in a vessel's hunting for the anchorage at Clallam Bay, or at Neah Bay, during the generally prevailing thick weather.

Lieut. H. T. Mayo, United States Navy, in charge of the Hydrographic Office, Port Townsend, in a letter to me makes the following statement:

> Clallam Bay is an anchorage often used by vessels to await favorable weather for going to sea. The holding ground is said to be good, and the anchorage fairly well protected from prevailing winds. Sometimes a heavy swell sets in, but I do not think a vessel was ever known to drag anchors so as to be endangered there.
>
> So far as I can learn, the great desideratum at Clallam Bay is a light and fog signal which would enable the anchorage to be located at night and in thick weather. Had these been established in 1892, I feel quite sure that the barks *Cowlitz* and *Majestic* would never have gone to sea in the weather in which they were lost.
>
> Capt. J. B. Libby, superintendent of the Puget Sound Tugboat Association, and an undoubted authority regarding these waters, suggests that Neah Bay would afford a small but sufficiently large harbor of refuge, and one far more advantageously located than Clallam Bay. It is at the entrance of the straits, could be used by inward-bound vessels as well as by those bound out, and could be made available by closing the passage between Waaddah Island and the mainland, and extending a breakwater from Keitlah Point. At present inward-bound vessels meeting easterly weather off the cape are obliged to lie off and await a change, while they might make into Neah Bay, were it available as a safe anchorage.

Mr. C. J. Smith, manager of the Oregon Improvement Company, which company has a number of vessels engaged in the coal shipping business, writes:

> A very important need is a light-house at Clallam Bay. This is especially needed by sailing vessels. There is no light between Tatoosh and Ediz Hook.

I have compiled on the accompanying map all the wrecks which have occurred in the Straits of Fuca and vicinity during the past twenty years of which I could obtain any knowledge. These wrecks are numbered in the order of their occurrence, and on the following table is given the statistics concerning them:

List of wrecks and disasters occurring in the Strait of Juan de Fuca and off Cape Flattery and adjacent coast, between the years 1874 and 1894.

[Abbreviations: Sch., schooner; Bk., bark; Bknt., barkentine; S. S., steamship; S. B., steamboat.]

No.	Name of vessel.	Rig.	Flag.	Date.	Nature of casualty.	Location.	Loss.	Cargo.	Remarks.
1	Christopher Mitchell.	Bk.	American	Mar. 2, 1874	Ran ashore in storm	Dungeness Spit	Total		
2	Pelicano	Ship.	Nicaraguan	Jan. 19, 1875	Stranded on rocks	Neah Bay	do		
3	Ontario	Sch.	American	Mar. 25, 1875	Went on rocks	San Juan Island	do		
4	Pacific	S. S.	do	Nov. 4, 1875	Collision	30 miles from Cape Flattery	do	General	236 lives lost.
5	Sabine	Sch.	do	Jan. 28, 1876	Stranded	Trial Island, Strait of Fuca	do		
6	Commodore	Ship.	do	Jan. 10, 1877	Stranded in a gale	2 miles from Tatoosh Island	do		
7	Orcas	Sch.	do	June 30, 1877	Stranded	San Juan Passage	$675		
8	Free Trade	Bknt.	do	Oct. 21, 1878	do	Near Quillayute River	11, 500		30 miles south of Cape Flattery.
9	Sword Fish	Bk.	British	—— —, 1878	do	Beecher Bay, Vancouver Island			
10	Teaser	S. S.	American	Mar. 2, 1879	Grounded	Sand bar, New Dungeness	1, 000		
11	H. C. Page	Sch.	do	Dec. 18, 1879	Stranded	Freshwater Bay, Strait of Fuca	1, 400		
12	Vidette	Bk.	do	Jan. 7, 1880	Struck a reef	Crescent Bay, Strait of Fuca	2, 000		
13	C. L. Taylor	Bknt.	do	May 7, 1880	Collision	8 miles northwest Cape Flattery	4, 000		
14	Rainier	Bk.	do	do	do	do	3, 000		
15	Albion	Sloop.	do	Dec. 14, 1880	Stranded	Crescent Bay, Strait of Fuca	Total		
16	David Hoadley	Bk.	do	Dec. 15, 1880	do	One-half mile from Point Wilson	do		
17	Seventy-six	Bk.	do	Jan. 26, 1881	Stranded in heavy sea	Neah Bay	1, 500		
18	Mastic	S. S.	do	May 31, 1881	Collision	2 miles northwest Crescent Bay, Strait of Fuca.	1, 000		
19	21st of May	Bk.	do	Dec. 10, 1881	Stranded	Race Rocks, Strait of Fuca	Total	Ballast	
20	C. L. Taylor	Bknt.	do	Feb. 18, 1883	Capsized and dismantled.	25 miles west southwest Cape Flattery.	do		
21	War Hawk	Ship.	do	Apr. 12, 1883	Fire	Discovery Bay	do		
22	Revere	Bk.	do	Sept. 9, 1883	Drifted ashore in a fog.	Port San Juan, Vancouver Island	do	Ballast	
23	Umatilla	S. S.	do	Feb. 9, 1884	Stranded	Umatilla Reef	Partial	Coal	Floated and repaired.
24	Lizzie Marshall	Bk.	do	Feb. 22, 1884	Drifted ashore in heavy gale.	Bonilla Point, Vancouver Island	Total	Ballast	1 life lost.
25	North Pacific	S. S.	do	May 22, 1885	Broke crosshead of engine.	8 miles from Victoria, British Columbia.	10, 000	General	
26	Duchess of Argyle	Bk.	British	—— —, 1885	Stranded	Sombrio Point, Vancouver Island			
27	Tacoma	S. S.	American	June 11, 1885	Collision	3 miles off Ediz Hook Light	3, 500		
28	Lizzie Merrill	Sch.	do	Oct. 28, 1885	Abandoned	Off Cape Flattery	Total	Ballast	
29	Richard Holyoke	S. S.	do	Jan. 17, 1886	Ran upon rock in a fog.	Bird Rocks, Rosario Strait	5, 000		
30	Aurora	Sch.	do	Feb. 14, 1886	Abandoned	Off Cape Flattery	Total	Lumber	
31	Reporter	Sch.	do	Aug. 10, 1886	Collision	Off Neah Bay	500		
32	Retriever	Bknt.	do	do	do	do	700		
33	Melfort	Bk.	do	Nov. 13, 1886	Fire	do	Total		
34	Belvedere	Ship.	do	Dec. 1, 1886	Drifted on rock	Bonilla Point, Vancouver Island	do	Ballast	
35	Sir Jamsetjee Family.	Bk.	British	do	Stranded	Near Cape Flattery	do	do	
36	Harvey Mills	Ship.	American	Dec. 15, 1886	Foundered	Off Cape Flattery	do	Coal	
37	Ella S. Thayer	Bk.	do	Dec. 16, 1886	do	do	do	do	
38	Irene	Brig.	Bolivian	Jan. 2, 1887	Water-logged	30 miles west southwest Cape Flattery.	do	Lumber	

List of wrecks and disasters occurring in the Strait of Juan de Fuca and off Cape Flattery and adjacent coast between 1874 and 1894—Continued.

No.	Name of vessel.	Rig.	Flag.	Date.	Nature of casualty.	Location.	Loss.	Cargo.	Remarks.
39	Webfoot	Bk.	American	Jan. —, 1887	Abandoned	Off Cape Flattery	Partial	Lumber	Went ashore at Crescent Bay, Oregon.
40	Austria	Bk.	do	Jan. 30, 1887	Stranded	Flattery Rocks	Total	Ballast	
41	St. Stephen	Ship.	do	Apr. 1, 1887	Foundered	Off Cape Flattery	do	Coal	
42	Eldorado	Bk.	do	do	do	Near Crescent Bay, Strait of Fuca	do	do	
43	Duchess of Albany	Ship.	British	Mar. —, 1888	Stranded	East of Bonilla Point, Vancouver Island.	do	Ballast	
44	Port Gordon	Bk.	do	Mar. —, 1889	do	25 miles south of Cape Flattery	do	General	
45	Ancon	S. S.	American	Aug. 28, 1889	Stranded on rock	Neah Bay	do	do	
46	Idaho	S. S.	do	Nov. 29, 1889	Grounded	Rosedale Reef, Strait of Fuca	do	do	
47	Alki	S. S.	do	Dec. 2, 1889	Bursting cylinder head	Off Cape Flattery	1,000		
48	Ferndale	S. S.	do	Jan. 27, 1890	Broken shaft	Dungeness Spit	500		
49	Granger		do	Apr. 15, 1890	Fire	Middle of Straits of Fuca	Total		
50	Guido			June 30, 1890	Loss of rudder	Crescent Bay, Straits of Fuca	500		
51	Savona	Bk.	Chilean	July 23, 1890	Stranded	Dungeness Spit	Total	Ballast	
52	Haytian Republic	S. S.	American	Oct. 31, 1890	Stranded on rock	Cape Flattery	500	General	
53	Atlanta	Bk.	do	Dec. 18, 1890	Dismantled in gale	30 miles from Cape Flattery	Total		Broke up in heavy sea.
54	Dare	Sch.	do	Dec. 30, 1890	Stranded	Carmenah Point, Vancouver Island	do		
55	Amelia		do	Feb. 20, 1891	Loss of sails	Abreast of Cape Flattery	2,000		
56	Fanny Dutard	Sch.	do	May 23, 1891	Collision	Middle of Strait of Fuca	6,000		
57	San Pedro	S. S.	do	Nov. 23, 1891	Stranded	Victoria Harbor, British Columbia	Total	General	
58	Dominion	Bk.	Norwegian	Dec. 21, 1891	Abandoned	Off Cape Flattery	Partial	Lumber	Towed to Victoria and condemned.
59	Premier	S. S.	British	Oct. 8, 1892	Collision	Off Bush Point	do	General	4 lives lost.
60	City of Kingston	S. S.	American	Oct. 25, 1892	do	Off Point Wilson	do	do	
61	Mary Parker	Sch.	do	do	do	Port Townsend Bay	do		
62	Margey	S. B.	do	Nov. 9, 1892	Foundered	Deception Pass	do		
63	Slanter	Bknt.	do	Nov. 18, 1892	Listed her cargo	Off Cape Flattery	do	Lumber	
64	Finland	Sloop.	do	Dec. 23, 1892	Foundered	Near Trial Island, Strait of Fuca	do		
65	Michigan	S. S.	do	Jan. 21, 1893	Stranded	16 miles west Carmenah Light-house	do	General	
66	Majestic	Bk.	do	do	Missing	Outside Cape Flattery	Total	Coal	Sailed from Seattle Dec. 10, 1892.
67	Cowlitz	Bk.	do	do	Capsized or foundered	do	do	Lumber	14 lives lost.
68	Lottie	Sch.	do	Jan. 31, 1893	Stranded	Dungeness Bay	200		
69	Columbia	Sch.	do	April 7, 1893	Leaking, lost boats and canoes.	Off Cape Flattery	Partial	Sealer	
70	J. C. Britain	S. B.	do	May 10, 1893	Stranded	On Bell Rock, Rosario Strait	Total		
71	Eritrea	Bk.	Chilean	Aug. 4, 1893	Run ashore in a fog	2 miles from Dungeness	20,000	Ballast	
72	Bonanza	Bk.	American	Sept. 5, 1893	Collision	Near Race Rock, Strait of Fuca	500	do	
73	Leonore	Bk.	Chilean	Oct. 4, 1893	Stranded	Cape Johnson, Pacific Ocean	Total	do	6 lives lost.
74	Mary Parker	Sch.	American	Dec. 30, 1893	Collision with drift-wood.	4 miles southeast Race Rocks, Strait of Fuca.	Partial		
75	Norway	Sch	do	Jan. 11, 1894	Collision	2 miles below Clallam Bay	Total	Lumber	Broke up on Vancouver Island.

76	Fanny Dutard	Sch.	do	do	do	do	1,400	do	Towed to Port Blakeley.
77	John C. Potter	Ship.	do	Jan. 16, 1894	Decks swept	Off Cape Flattery	Partial		
78	Thermopylea	Bk.	British	Feb. —, 1894	Sails carried away	do	do	General	
79	R. K. Ham	Bk.	American	Mar. 10, 1894	do	do	do	Ballast	
80	J. B. Leeds	Sch.	do	Mar. 11, 1894	do	20 miles off Cape Flattery	do	do	
81	C. C. Funk	Bknt.	do	do	do	do	do	do	
82	Archer	Bk.	British	Mar. 27, 1894	Dismantled and abandoned.	do	Total	do	
83	Alcalde	Bk.	American	Apr. 29, 1894	Grounded	Smiths Island, Strait of Fuca	Partial		
84	Dispatch	S. B.	do	May 5, 1894	Fire	Friday Harbor, San Juan Island	do	General	
85	Emma Louisa	Bk.	Chilean	June 11, 1894	Leaking	Off Cape Flattery	do	Lumber	Returned to Port Townsend.
86	R. K. Ham	Bk.	American	July 2, 1894	Stranded	On Dungeness Spit	Total	Ballast	
87	Helen Foster	Bk.	do	(?)	do	Neah Bay	do		
88	Mallory	Bk.	do	(?)	do	do	do		
89	W. H. Banks	Bk.	do	(?)	do	Slip Point, Strait of Fuca	do		
90	Ocean	Bk.	do	(?)	do	On Dungeness Spit	do		
91	Geo. Washington	Bk.	do	(?)	do	do	do		
92	Washington Libby	Ship.	do	(?)	do	do	do		
93	Gem of the Ocean	Bk.	do	(?)	do	Vancouver Island, British Columbia.	do		Near mouth of Jordon River.
94	Ivanhoe	Ship.	do	Oct. 4, 1894	Missing	Outside of Cape Flattery	do	Coal	Sailed from Seattle Sept. 27, 1894.

SUMMARY.

Casualties.	Number.	Remarks.
Vessels stranded in heavy gales and otherwise	45	Of this number 34 occurred in Strait of Juan de Fuca.
Vessels foundered	6	Of this number 2 occurred in Strait of Juan de Fuca.
Vessels capsized and abandoned	9	All occurred off Cape Flattery.
Vessels leaking and otherwise disabled by storms	14	Of this number 10 occurred off Cape Flattery.
Vessels in collision	14	Of this number 8 occurred in Strait of Juan de Fuca.
Vessels burned	4	Of this number 2 occurred in Strait of Juan de Fuca.
Vessels missing	2	Outside of Cape Flattery.
Vessels foundered or stranded	14	Along southwest shores of Vancouver Island; exact location not recorded.
Total	108	

The advisability of improving Clallam Bay so as to convert it into a harbor of refuge depends on several considerations, principal among which are—

First. Whether any harbor of refuge is needed in the general locality.

Second. If a harbor of refuge is needed, is Clallam Bay the best and most suitable place for it? And

Third. The cost of constructing a harbor of refuge at Clallam Bay.

First. It would certainly be a very great convenience and benefit to navigation if a harbor, good, safe, well protected, easily reached and easily departed from, existed near the entrance to the Straits of Fuca.

It would be desirable for departing vessels, enabling them to sail, tow, or steam to the harbor, and there await, if necessary, favorable conditions of weather and sea outside.

It would also be in many cases advantageous for vessels entering the straits after a long or rough voyage, or if partially disabled, enabling them to fit themselves for the trip inward, to await tugs, etc.

Such a harbor would also be a desirable place for tugs to congregate and wait for business, or for bad weather to pass.

Second. Clallam Bay is, in my opinion, not properly situated for a harbor of refuge in or about the Straits of Fuca. Its distance, 24 miles from the entrance, is too great.

Vessels departing and meeting heavy weather and strong seas outside would be but poorly served by a harbor of refuge or a harbor of waiting 24 miles on their back track.

Vessels entering, if they could safely reach Clallam Bay, 24 miles from the entrance, could without much increased hardship, discomfort, or danger reach Port Angeles or the Royal Roads, 30 miles farther away on their course.

Third. The cost of improving Clallam Bay as a harbor of refuge would be enormous. Without intending to formulate any plan or make any estimate of cost, it may be stated that to give shelter to the good anchorage area of the bay would require a breakwater some 8,000 feet long, built in water of an average depth of about 50 feet.

Furthermore, it may be stated that the local interests on Clallam Bay are not sufficient in amount or of such a nature as to justify any large expenditure for the improvement of its existing commercial facilities.

After a full consideration of all the facts in the case which I have been able to gather bearing on the subject, and which are epitomized in the preceding report, I am of the opinion that Clallam Bay is not worthy of improvement by the General Government, with the end in view of converting it into a harbor of refuge.

I have had letters from and interviews with many persons engaged in or in some manner connected with the shipping industry through the Straits of Fuca, and not one has expressed himself favorably to Clallam Bay as a harbor of refuge. They all point to Neah Bay as a much more desirable location.

Although somewhat foreign to the question at issue, and without expressing any individual opinion, it may be stated that the results of my investigations show a strong concensus of opinion as to the great desirability of three things which would be much more appreciated by commercial interests than a harbor of refuge at Clallam Bay:

First. A light-ship located near the entrance of the Straits of Fuca.

Second. A light and fog signal at Clallam Bay to guide to the anchorage there in thick weather; and

Third. The construction of a harbor of refuge at Neah Bay.

Lieut. F. R. Shunk, Corps of Engineers, made a personal examination of Clallam Bay, and I submit herewith his report.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded.

Neah Bay, being adjacent to the open sea, is the most accessible shelter for vessels entering the Straits of Juan de Fuca, and the most convenient for vessels awaiting suitable weather for departure. If a harbor of refuge is needed in this vicinity, the site of Neah Bay is, on every account, to be preferred to Clallam Bay.

The improvement required to make Clallam Bay a harbor of refuge is not regarded as worthy to be undertaken by the General Government.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF FIRST LIEUT. FRANCIS R. SHUNK, CORPS OF ENGINEERS.

PORTLAND, OREG., *October 6, 1894.*

SIR: I have the honor to submit the following report of an examination of Clallam Bay, Washington, made by me September 10-11, 1894.

Clallam Bay is on the southern shore of the Straits of Juan de Fuca, about 24 miles east of Cape Flattery. There are two villages on the bay, East and West Clallam. The population of East Clallam is about 150; that of West Clallam considerably less. The steamer *Willapa*, which makes three trips a week between Seattle and Neah Bay, stops at East Clallam. A trail leads from this place to Lapush and other points in the Quillayute Valley, and the people within a radius of 15 or 20 miles, perhaps 500, get their provisions at East Clallam. The country is sparsely settled. There is a sawmill at East Clallam, which employs about one hundred men, including loggers, and whose output is 50,000 feet per diem. This is the chief industry of the country. The lumber is shipped chiefly to San Francisco in sailing vessels, which sometimes bring back supplies at about $1.50 per ton. The mill company likewise own a general store and a hotel. There are also a saloon, a restaurant, and a livery stable. A pack train leaves three times a week for Beaver, 20 miles distant, in the Quillayute Valley; the minimum charge is $20 per ton.

Apart from the lumber business, most of the trade is with Seattle; the *Willapa* charges $5 per ton for freight to and from Seattle. Arrangements are being made to have the steamer *Farallon*, of San Francisco, stop on her way to Seattle three times a month; it is said that her charge will be only $3.

A map of Clallam Bay accompanies this report. The bay is about 2 miles wide and 1 mile deep. The depth of water across the entrance is 10 to 12 fathoms. The 3-fathom curve is quite close to the shore. The bottom is rocky in places, but is said to be chiefly of sand and gravel. The anchorage is good.

There is nothing remarkable about the currents. The tidal currents in the straits have a maximum velocity of about 3 miles per hour, and produce eddy currents in the bay. The Clallam River, which empties into the bay, is so small as to be negligible.

This part of the strait is subject to fogs, especially in summer. A like effect is often produced by the thick smoke from burning forests. There is no light-house or fog signal on the west, nearer than Tatoosh Island, 20 miles away; on the east nearer than Ediz Hook, about 30 miles away.

The points inclosing the bay, Slip Point to the east, and Sikyu or Sekou Point to the west, are quite high, and the bay is well protected to the east, south, and west. It is, however, quite open to the north.

During the winter the prevalent winds are southerly. Sometimes a southeast wind causes a heavy sea in the strait. From these winds the harbor is quite sheltered. The summer winds are northerly, and from these there is no shelter to speak of. A northeast storm sometimes forces vessels to leave the bay. Both fogs and winds are heaviest at the entrance to the strait and decrease inward.

The advisability of improving Clallam Bay as a harbor of refuge depends upon two principal considerations: First, the necessity of a harbor of refuge in those parts, and, second, the suitability of Clallam Bay for the purpose. I understand that my instructions do not require a discussion of the first question. The suitability of Clallam Bay would depend partly upon its location and partly upon the physical characteristics.

Clallam Bay is the only available location between Neah Bay and Port Angeles. In my opinion it is too far from the entrance to the strait. The weather is almost uniformly worse and the danger greater at the mouth of the strait than anywhere within, and I think that a harbor of refuge ought to be somewhere near the mouth.

As regards physical characteristics, the depth of water, area, and anchorage at Clallam Bay appear to be suitable. On the other hand, the entrance is very wide. To obtain efficient protection from the north would probably involve the construction of at least a mile of breakwater in a depth of 10 to 12 fathoms; this would be very costly.

For these reasons it is my opinion that Clallam Bay is not worthy of improvement as a harbor of refuge.

Very respectfully, your obedient servant,

FRANCIS R. SHUNK,
First Lieut., Corps of Engineers.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

T T 26.

PRELIMINARY EXAMINATION FROM HOODS CANAL, IN PUGET SOUND, WASHINGTON, TO NORTH BAY, IN SAID SOUND, WITH A VIEW OF CONSTRUCTING A WATERWAY AND CHANNEL BETWEEN THE TWO BODIES OF WATER AT THE MOST PRACTICABLE PLACE OF SUFFICIENT DEPTH TO BE NAVIGABLE FOR ALL CLASSES OF VESSELS.

[Printed in House Ex. Doc. No. 240, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 1, 1895, with map,* by Capt. Thomas W. Symons, Corps of Engineers, upon preliminary examination from Hoods Canal, in Puget Sound, Washington, to North Bay, in said Sound, "with a view of constructing a waterway and channel between the two bodies of water at the most practicable place of sufficient depth to be navigable for all classes of vessels," made to comply with the provisions of the river and harbor act of August 17, 1894.

Captain Symons submits the opinion that the slight advantages to be derived from the proposed waterway and channel, combined with its enormous cost, render the improvement unworthy to be undertaken by the United States Government at the present time. Col. G. H. Mendell, Corps of Engineers, the division engineer, reports that, for the reasons given, this locality is not regarded as worthy of improvement.

I concur in the views expressed by these officers.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

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* Omitted. Printed in House Ex. Doc. No. 240, Fifty-third Congress, third session.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report on the preliminary examination for a waterway between Hoods Canal and North Bay, Washington, required by your letter of August 20, 1894.

The language of the law requires a preliminary examination "from Hoods Canal, in Puget Sound, Washington, to North Bay, in said Sound, with a view of constructing a waterway and channel between the two bodies of water at the most practicable place of sufficient depth to be navigable for all classes of vessels."

North Bay is not named on the Coast Survey maps, but it is the local name, and is understood to be the north end of Cases Inlet, where it comes closest to Hoods Canal.

A map is submitted herewith which shows the relation of the various arms of Puget Sound to each other, and on a much larger scale the country in the vicinity of Hoods Canal and North Bay.

The portion of Puget Sound south of Port Townsend is divided at Foulweather Bluff into two unequal portions. The eastern and greater portion, and by far the most important, receives the drainage of the western slopes of the Cascade Mountains. Upon it are many broad and fertile stretches of agricultural land, besides vast quantities of timber land; and upon it are situated the principal cities of the Sound country—Seattle, Tacoma, Everett, and Olympia. The latter, the capital of the State, is situated at the extreme southern end of the Sound, on one of the numerous branches into which it divides.

The western and lesser arm is known as Hoods Canal. This is about 97 miles long and in the form of a fishhook, as shown on the map herewith.

The waters generally throughout Hoods Canal and Puget Sound are very deep, averaging probably 300 feet, and with extreme depths of over 800 feet. Shallows of small extent exist at the head of the numerous arms and about the mouths of the rivers.

The shores of Hoods Canal are generally steep and abrupt hills, ranging from 300 to 3,000 feet high.

The head of Hoods Canal and the head of North Bay come within about 2 miles of each other, as shown on the map herewith.

This proximity of the heads of Hoods Canal and North Bay has naturally suggested a waterway between the two, and the project has been many times mentioned. Some years ago a town was laid out in the vicinity, and its projectors laid stress upon its importance, due to the canal to be constructed between the two bodies of water.

The proposed waterway and channel may properly be considered from a commercial standpoint and from a military standpoint.

In my opinion, from neither of these standpoints is the improvement outlined worthy of being undertaken by the General Government at the present time.

Shipping can now reach in a convenient manner every point of Puget Sound proper and every point of Hoods Canal. The proposed waterway would shorten the distance between the entrance to the Sound and points thereon in but very few instances. From Olympia, at the extreme southern end of Puget Sound, it is a shorter water distance by the existing open channels than it would be via the proposed cut and Hoods Canal, and with better and wider water to traverse.

The only commercial use and convenience which the proposed cut would serve would be in those cases when a single ship had business both at the head of Hoods Canal and in the upper waters of Puget Sound proper. In such a case the cut would avoid the long passage around. Such cases are not now, and are not likely to be in the future, of frequent occurrence. The proposed cut would probably be of some slight convenience to steamboats from the commercial centers of Seattle and Tacoma, enabling them to make a wider trading circuit on a single voyage.

The benefits above outlined are entirely incommensurate with the cost of the improvement.

The principal industry of the population living on Hoods Canal and North Bay is the lumber industry. There are probably less than 4,000 acres of land on Hoods Canal and North Bay under cultivation. The total population along Hoods Canal is about 1,200 to 1,600 souls, and there are about 100 near the head of North Bay.

There are three sawmills on Hoods Canal, at Port Gamble, Quilcene, and Union City; also one shingle mill at Union City.

The report of Mr. Eugene Ricksecker, civil engineer, who made the personal examination required, and which is herewith, gives more in detail the industrial condition of the country.

From a military standpoint it is evident that under certain conceivable conditions it might be advantageous if there were a passageway for war ships and vessels of all kinds from deep water in North Bay to deep water in Hoods Canal. These conditions are, however, of so remote and uncertain a character that they are not at the present time worthy of consideration.

The country intervening between the head of Hoods Canal and North Bay was examined. The contour map herewith indicates the topographical features of the region. It is taken from the Coast Survey charts, with additions by Mr. Ricksecker.

The general elevation of the ridge between the two waters is 300 feet. All indications are that the ridge is composed of gravel, sand, and clay, and that no rock would be met with in making a cut through. The absence of a proper water supply for a high-level canal renders it necessary only to consider a sea-level canal.

On the map a profile is given on the shortest line between the waters. This is approximately the most practicable place for the waterway, and shows the enormity of the proposed work.

The distance between waters on this line is almost exactly 2 miles, and the cut would average about 240 feet deep. With a bottom width of 40 feet, depth of 26 feet, and side slopes of 1 on $1\frac{1}{2}$, the amount of excavation involved in the cut would be over 51,000,000 cubic yards. It is probable that no route could be selected which would lower this amount to any appreciable extent.

Besides this it would be necessary to excavate channels in the shallows at the heads of Hoods Canal and the North Bay, to enable vessels to reach the cut through the divide. This would involve about 1,500,000 cubic yards of dredging.

In conclusion I beg to again submit the opinion that the slight advantages to be derived from the proposed waterway and channel, combined with its enormous cost, render the improvement unworthy to be undertaken by the United States Government at the present time.

The report of Mr. Eugene Ricksecker, civil engineer, who made the personal examination, is herewith.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded.

This project is uncalled for by commercial requirements, and its cost must be enormous. For these reasons it is not regarded as worthy of improvement.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. EUGENE RICKSECKER, ASSISTANT ENGINEER.

PORTLAND, OREG., *October 6, 1894.*

SIR: On receiving your letter dated September 12, 1894, directing me to make an examination "from Hoods Canal in Puget Sound, Washington, to North Bay in said Sound, with a view of constructing a waterway and channel between the two bodies of water at the most practicable place, of sufficient depth to be navigable for all classes of vessels," I at once made preparations to carry out your instructions.

Hoods Canal—named by Vancouver in his explorations of 1792, a natural channel or arm of Puget Sound—extends in a southwesterly direction for 83 miles, then bends sharply to the east and continues in a northeasterly direction 14 miles farther.

Its depth ranges from 140 to over 500 feet, while its shores are lined with abrupt hills rising from 300 to 3,000 feet above the water's surface. The lower hills are said to be composed mainly of gravel and sand. A clay subsoil is found on the eastern shore for perhaps half the canal's length on the south shore of the hook and in a few small valleys.

Very little land along the canal is suitable for cultivation—perhaps 1 acre in 100. It is covered at the present time with fir, cedar, and spruce timber, the best of which near the water's edge has been logged off.

Numerous small streams empty into the canal from both sides, and along these there is, with the exception noted below, a very limited amount of land that can be, and some of which is, cultivated.

From estimates given by a number of people living along the canal the following is tabulated:

Location.	Cultivated land.	Susceptible of cultivation.
	Acres.	*Acres.*
Quilcene	2,000	4,000
Skokomish River	1,000	1,000
Union River	320	800
Tahuyeh River	50	400
Elsewhere	40	.....

The principal towns are as follows:

Quilcene, with a population of about 400, a hotel, barber shop, two blacksmith's shops, two general stores, three carpenter's shops, and a sawmill with a daily capacity of about 4,000 feet B. M.

Port Gamble, 6 miles inside the mouth of the canal, 37 miles from Seattle, has a population of about 350, a large sawmill, and a general merchandise store. The

town is owned by the Puget Mill Company, who ship lumber all over the Pacific coast. It receives a daily mail from Seattle and Port Townsend, and a triweekly mail from the towns along the canal.

Union City, 46 miles from Port Gamble, has a population of 300 people, two hotels, one sawmill, one shingle mill, one drug, one grocery, and one general merchandise store, the latter doing a business of from $8,000 to $10,000 annually; one blacksmith shop, one shoe shop, one non-denominational church, and a $3,000 schoolhouse. There is a daily stage and mail to Shelton, except Sundays. A daily boat and triweekly mail to Seattle and down canal points. Fare, $1.50.

About 5,000,000 feet of logs are shipped annually to the mills at Port Gamble, Blakely, Tacoma, and Hadlock.

Nearly 300 tons of hay are shipped annually from the Skokomish River. Some live stock is sent to Shelton and used in the county.

Hoodsport, 42 miles from Port Gamble, with a population of about 50 people, contains two hotels, general merchandise store, blacksmith shop, Pacific Postal Telegraph office, and large schoolhouse. A stage runs to Lake Cushman.

Iron and copper mines are located 12 miles from here, but no ore has been shipped. A brig of some 300 tons' burden is now on her third trip from San Francisco after piles. On her last trip she brought up 2 tons of groceries. Her freight charges are 5 cents per running foot on piles, and $3.50 per ton on freight.

Lilliwaup, 40 miles from Port Gamble, is a summer resort noted for its waterfalls. These are situated about a quarter of a mile from the canal and have a total fall of 270 feet, divided into four main falls or cascades. The town is composed of a hotel and post-office, and has a population of about 20 people.

Dewath post-office, nearly opposite Lilliwaup, on the east shore, contains about 20 people.

Holley and Bangor post-offices have about 30 inhabitants.

Seabeck, 20 miles from Port Gamble, is a deserted town of some 40 houses. It was formerly the site of a large sawmill, which burned in 1885, and has not been rebuilt.

Clifton, at the head of the canal on the Union River, has a population of about 20 souls, a general merchandise store and blacksmith shop, a daily mail (horseback) to Seattle via Sidney and Port Orchard, 14 miles, and to Allyn on North Bay, 6 miles, triweekly.

About 40 tons of potatoes and 300 tons of hay are shipped from here annually. Oysters are shipped to Seattle and Tacoma by wagon road across a narrow ridge to North Bay, and then by boat to destination. The shipments amount to from 3 to 5 bushels per week in season. The beds are fast being depleted, partly through carelessness in replacing the culls, and partly by exposure to heavy frosts occurring when the beds were bare on an extreme low tide.

A steam logging road, 7 miles long, the property of the Puget Mill Company, is in operation at intervals.

Allyn, at the head of low-tide navigation on North Bay, 42 miles from Tacoma, has a population of about 50 people. It contains a general merchandise store and post-office, and a boarding house where lodging can be obtained.

A steamer carrying mail makes the round trip to Tacoma daily, except Sundays; fare, 50 cents.

Logging is the chief industry, although little has been done the past year and a half.

The farming land in this vicinity under cultivation is confined to small garden tracts insufficient to supply home demand.

Goods are purchased in Tacoma and Seattle in about equal quantities.

A railroad has been surveyed from here to Clifton, and a portion of it has been graded.

Lumber.

Company.	Daily capacity.	Cut in 1890–91.	Cut in 1892.	Remarks.
	Feet.	*Feet.*	*Feet.*	
Quilcene mill	4,000	.....	.....	Home consumption.
Union City sawmill	25,000	6,000,000	1,500,000	Home consumption, almost entirely.
Union City shingle mill	50,000	.....	.....	Local trade only.

Lumber—Continued.

CUT IN 1893.

Company.	Domestic.		Foreign.
	Puget Sound.	Coast.	
	Feet.	*Feet.*	*Feet.*
Puget Lumber Co	702, 000	30, 737, 000	15, 964, 000

CUT FIRST HALF OF 1894.

Quilcene mill	100, 000	.....	.....
Union City sawmill	2, 000. 000	.....	.....
Union City shingiemill	100, 000	.....	.....
Puget Lumber Co., Port Gamble	1, 668, 000	8, 532, 000	6, 357, 000

Puget Lumber Company's shipment for the month of September, 1894, is as follows: To Honolulu, 1,537,000 feet of lumber, 14,175 linear feet cedar poles (445); to California, 2,636,000 feet of lumber, 462,200 pieces laths, 27,010 linear feet piling (1,300).

Steamers, vessels, etc.—The *Idaho*, running from Seattle to Port Townsend, touches at Port Gamble daily, except Sundays.

Two passenger and freight boats, the *Delta* and *Ranier*, run one way on alternate days, except Sundays, from Seattle to Union City, touching at all intermediate points on the canal.

The *Monte Cristo* daily, except Sundays, from Tacoma, making connection with the *Susie* for Allyn.

The schooner *American Ranger* makes monthly trips from Seattle to Quilcene Bay.

A brig is on her third trip to Honolulu from San Francisco.

Numerous vessels lie at the Puget Mill Company's wharves at Port Gamble, loading lumber for various points on the Pacific.

Examination of ridge between Hoods Canal and North Bay.—Lieutenant Case, in 1841, first discovered this narrow isthmus, which is, at the narrowest place, 2 miles wide. The general elevation of the ridge is 300 feet. Its maximum elevation is 368 feet and the lowest pass is 210 feet.

A reconnoissance was made crossing from water to water three times and along the backbone of the ridge and its spurs twice. From these trips with aneroid and compass the accompanying contour map of the region is compiled, drawing largely from Coast Survey chart No. 6460.

Two projects for a canal were considered, namely: A high-level canal and a sea-level canal.

The first is impracticable through lack of water supply. Lake Debro, called Kellums Lake by Lieutenant Case, which lies almost in the path of the shortest route, is a shallow water body having less than three-fourths of a square mile drainage basin. It is said to be 40 feet deep in places, but the ends are shallow and considerable change in its outline occurs from season to season.

The second project, the only feasible one, will require an average cut of 240 feet for 2 miles at the narrowest point, a maximum cut of 280 feet with dredging across 25,000 feet of tide flats to obtain 26 feet of water at low tide.

The examination of wells, railroad cuts, etc., indicates that the ridge is composed largely of gravel and sand, formed by glacial action, and probably a medial moraine. It is reasonably certain that no rock will be found other than the large bowlders common to glacial drift.

Estimate.—Assuming a bottom width for a canal of 40 feet width and 26 feet depth of water at low tide, with slope of 1½ to 1, and a berm on each side above high tide of 20 feet, we have along the route of the shortest line between Hoods Canal and North Bay, the removal of 51,500,000 cubic yards of earthwork.

	Cubic yards.
Dredging in North Bay	418, 000
Dredging in Hoods Canal	1, 095, 000
Total	1, 513, 000

Conclusion.—There is at this time no commerce to warrant the building of such a canal and no prospect of an early change in the existing conditions. Taking the broadest possible view, since there is little agricultural land to support a large population, the only commerce that might be benefited by this work is the logging

interest, where the towing distance to but one of the largest mills on the Sound would be reduced by 54 miles, and an uncertain quantity of ore that may be mined at some future time.

The general opinion of the people living along the canal is that there is no demand for the improvement other than the circulation of money in that region.

Respectfully submitted.

EUGENE RICKSECKER, *Assistant Engineer.*

Capt. T. W. SYMONS.

T T 27.

PRELIMINARY EXAMINATION OF BELLINGHAM BAY, WASHINGTON.

[Printed in House Ex. Doc. No. 228, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated January 1, 1895, by Capt. T. W. Symons, Corps of Engineers, upon a preliminary examination of Bellingham Bay, Washington, made in accordance with the requirements of the river and harbor act of August 17, 1894.

In regard to the shoaling in the northwestern portion of the bay about the mouth of Nooksack River, Captain Symons states that—

> While it seems desirable and advisable to make a survey to determine the amount and rate of shoaling and to arrive at a satisfactory and definite understanding thereof, I am not with my present knowledge of the opinion that in this particular feature Bellingham Bay is worthy of improvement by the General Government.
>
> He is of the opinion, however, that this locality is worthy of improvement to the extent of removing Starr Rock, and this opinion is concurred in by Col. G. H. Mendell, Corps of Engineers, the division engineer, and by me.
>
> It is estimated that a survey necessary for the preparation of project for removal of Starr Rock, with estimate, will cost $100.
>
> The cost of a survey to determine the extent of shoaling over the entire area of the bay is estimated at $1,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report of the preliminary examination of Bellingham Bay, Washington, required at my hands by your letter of August 20, 1894.

Bellingham Bay is a portion of the great body of water to which, as a whole, the name Puget Sound is now generally applied. It reaches to within 15 miles of the international boundary line, and it opens out into that portion of Puget Sound in which are situated the islands forming the San Juan Archipelago.

It is about 10 miles long from north to south, and 5 miles wide from east to west. It has an average depth of about 10 fathoms, with a maximum depth, according to the Coast Survey charts, of 26 fathoms. It is this fact of its being sufficiently shallow to allow anchorage that favorably distinguishes Bellingham Bay from most of the other harbors of Puget Sound. Upon it are situated the cities of New Whatcom and Fairhaven.

The improvement of Bellingham Bay in two particulars has been demanded by a greater or less number of the people of the bay. The first feature is connected with the shoaling of the bay by the deposits brought down by the Nooksack River. Some two years ago statements were made to me that the whole upper or northern portion of the bay was shoaling rapidly, and that in order to prevent it from continuing the Nooksack River should be turned into its old course, into Lummi Bay.

Investigation revealed the fact that the statements were not well founded. A comparison was made by me of the Coast Survey data gathered in 1855 and the data gathered in 1891 by Captain Gilbert, of the Coast and Geodetic Survey, covering the northwestern portion of the bay, in the vicinity of the cities of New Whatcom and Fairhaven. The result of the comparison was to show that the bottom of the bay was practically identically the same at the two dates.

There has unquestionably been a considerable deposition of sediment in the northwestern portion of the bay, about the mouth of the Nooksack River, but it has not yet extended over a very largeportion of the bay, or to an extent sufficient to justify any fear of damage to the commerce of the bay for many years to come.

I think it would be well, however, to make a survey to determine accurately the extent and rate of the shoaling.

While the Nooksack River must be considered detrimental to the bay to a certain extent, due to the deposits brought down, it is esteemed to be of great value, in that its fresh waters circulating about the fronts of New Whatcom and Fairhaven prevent the ravages of the teredo among the pile wharves, etc., with which the shores are lined.

So important is this fresh water considered that a very strong protest would go up against the project of deflecting it from the harbor.

While it seems desirable and advisable to make a survey to determine the amount and rate of shoaling and to arrive at a satisfactory and definite understanding thereof, I am not, with my present knowledge, of the opinion that in this particular feature Bellingham Bay is worthy of improvement by the General Government.

The second feature of Bellingham Bay in respect to which improvement is demanded is the existence of a rock known as Starr Rock, situated near the eastern shore of the bay between Fairhaven and New Whatcom. This rock, being directly in the locality of the two cities and where the maximum movement of shipping takes place, is a danger and a menace, and should be removed.

In my opinion Bellingham Bay is worthy of improvement to the extent of removing Starr Rock.

The cost of a survey to determine the amount of work involved in the removal of this rock would be about $100.

If a survey should be ordered to determine the extent of shoaling over the entire area of the bay it would cost, it is estimated, $1,000.

Commercial statistics.—I have the honor to submit herewith a letter relative to the commerce centering in Bellingham Bay from the secre-

tary of the Whatcom Board of Trade and the secretary of the Commercial Club of Fairhaven.

New Whatcom is the county seat of Whatcom County, has a population of about 7,500, and is a subport of entry for Puget Sound.

COMMERCIAL CLUB,
Fairhaven, Wash., November 8, 1894.

DEAR SIR: Replying to your favor of recent date, we hand you herewith such information as we have at hand pertaining to the commerce of Bellingham Bay:

In the matter of freight, about 2,000 tons per month are now handled at the three principal wharves, this amount of course being independent of shipments by rail.

The custom-house records, New Whatcom being a subport of entry, show that during the year 1893 there were 31 entries of vessels engaged in foreign trade and 74 clearances, and, in addition, there were numerous vessels plying between here and Seattle and Tacoma, the San Juan Islands, Samish Flats, Nooksack, and Skagit rivers, etc., engaged in the coasting trade and the transportation of agricultural products, lumber, shingles, etc.

From July 1 to December 31, 1893 (later figures not now at hand), the customs valuation of exports was $109,614.

In the territory immediately contiguous and contributory to Bellingham Bay there are 15 sawmills whose annual output is 80,000,000 feet and 40 shingle mills which manufacture annually 300,000,000 shingles, the daily shipments aggregating about 25 car loads.

Very valuable coal mines convenient to tide water are being opened, the output of which is steadily increasing. From one of them, the Blue Canyon, the vessels of the Revenue-Marine Service in this district are supplied, and from it also the Government this year purchased coal for a number of vessels of the Bering Sea fleet, and quite recently for the U. S. S. *Monterey*.

The Bellingham Bay and British Columbia Railroad, connecting with the Canadian Pacific, the Bellingham Bay and Eastern, reaching to the coal mines, and the Great Northern Transcontinental Line reach tide-water here and afford first-class railroad facilities, and, in addition, the Northern Pacific system crosses the central portion of the county.

Very truly, yours,

C. W. ROBERTS,
Secretary Whatcom Board of Trade.
O. H. CULVER,
Recording Secretary Commercial Club

Capt. T. W. SYMONS,
United States Corps of Engineers.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded.

This port is regarded as worthy of improvement to the extent of removal of Starr Rock, it being a danger in navigation.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

T T 28.

PRELIMINARY EXAMINATION OF OKANOGAN RIVER, WASHINGTON, FROM MOUTH TO HEAD OF NAVIGATION.

[Printed in House Ex. Doc. No. 238, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1895.

SIR: I have the honor to submit the accompanying copy of report of January 1, 1895, by Capt. Thomas W. Symons, Corps of Engineers, upon preliminary examination of Okanogan River, Washington, "from mouth to head of navigation," made in accordance with the provisions of the river and harbor act of August 17, 1894.

It is the opinion of Captain Symons, concurred in by the division engineer, Col. G. H. Mendell, Corps of Engineers, and by this office, that the Okanogan River is worthy of improvement by the General Government.

It is estimated that the survey of the river on which to base a project for its improvement will cost $1,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit herewith report of the preliminary examination of the "Okanogan River, Washington, from its mouth to the head of navigation," required from me by your letter of August 20, 1894.

It is my opinion that the Okanogan River is worthy of improvement by the General Government.

The Okanogan River is about 190 miles in length. Rising in British Columbia, it flows southerly along the eastern base of the main range of the Cascade Mountains, and empties into the Columbia at the point where the latter river makes its last great bend to the southward. Like most of the rivers of this locality, it is in its upper course a succession of lakes, which act as reservoirs to prevent excessive floods and to regularize the flow. The river really has its source in Okanogan Lake, a magnificent body of water about 60 miles long and 2 to 3 miles in width and of great depth.

At the boundary line between the United States and British Columbia the river widens out into Osoyoos Lake, and from this lake to the Columbia the portion in our territory, 75 miles in length, has a fall of about 80 feet, or an average slope of but little over 1 foot to the mile.

The average width of the river is about 250 feet. It flows in a succession of quiet pools, separated by little riffles, and is generally well suited to navigation throughout its extent in our territory. There is, however, one principal obstruction to the navigation of the river, at a point about 45miles from its mouth. Here the water is dammed up by a rocky reef so that its slope in escaping is very steep, it forming a suc-

cession of rapids with a total fall of about 6 feet at low water. This rapid stretch is known locally as McLaughlin Falls. The river here is about 60 yards wide, and is divided at low water by a mass of rock in the middle. As far as known, there is no obstruction to the free navigation of the river between McLaughlin Falls and Osoyoos Lake at the boundary. The only obstruction between the mouth of the river and McLaughlin Falls, worthy of notice, is at Guthrie Rapids, about 35 miles above the mouth. Here there are a few troublesome rocks and a fall of 2 or 3 feet in two principal rapids.

It is believed that at a comparatively small cost the whole river can be converted into a continuous watery highway from the mouth to the boundary line, and probably for some distance above this.

A survey of the river on which to base a project for its improvement would, it is estimated, cost about $1,000.

Until within a few years ago the country lying on both sides of the Okanogan River was Indian reservation; the Columbia Reservation to the west and the Colville Reservation to the east.

The tying up of the lands as Indian reservations has prevented their development.

The whole of the Columbia Reservation is now thrown open and the northern portion of the Colville Reservation soon will be, and the country can be expected to develop more rapidly in the future.

The development of this Okanogan country has also been seriously handicapped by its inaccessibility and the difficulty of transportation.

The recent completion of the Great Northern to and across the Columbia River near the mouth of the Wenache places the country bordering on the Okanogan within communication by rail and water with the commercial centers of the country.

Nearly all the development of the Okanogan country is, however, above McLaughlin Falls, hereinbefore mentioned, and to enable the region to derive full benefit from its situation the navigation of the river must be made continuous to the boundary line.

The steamer *City of Ellensburg*, which plies regularly on the Columbia between Wenatchee and the mouth of the Okanogan River, has, during the past two years, made many trips up the river to the McLaughlin Falls and points below.

It is impossible to get any accurate statistics regarding the business done on the river.

The chief resources and interests of the country which have, up to the present time, been developed are mining and stock raising. There are important and rich mines of gold and silver which will be benefited by the increase in transportation facilities, which the work herein mentioned would bring about. Chief among these are the mines of the Chloride, Ruby Hill, Mineral Hill, Lime Belt, Pine Creek, Palmer Mountains, Wanicott Lake, and Mount Chapaca districts.

The working of these mines is badly handicapped by the difficulties of transportation.

For further and more detailed information relating to the Okanogan and the country in its vicinity reference is made to the report of Lieut. F. R. Shunk, Corps of Engineers, which is herewith.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded.

The Okanogan River is, for reasons stated in these reports, considered to be worthy of improvement by the General Government.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF FIRST LIEUT. FRANCIS R. SHUNK, CORPS OF ENGINEERS.

PORTLAND, OREG., *November 15, 1894.*

SIR: I have the honor to submit the following report of an examination of the Okanogan River, Washington, made by me October 11-20, 1894. A map* of the river and adjacent country accompanies the report:

The Okanogan River rises in the Dominion of Canada, in latitude 50° 29′, longitude 119° 29′. It empties into the Columbia River in the State of Washington in latitude 48° 06′, longitude 119° 45′, about 3 miles above Virginia City. The total length of the river is about 190 miles; its general course is southerly. In its upper course it flows through Okanogan, Dog, Vaseux, and Osoyoos lakes.

Okanogan Lake is a fine body of water 60 miles long by 2 or 3 wide. Its southern end is about 30 miles north of the boundary. Osoyoos Lake lies on the boundary line.

The total drainage area of the river is about 6,300 square miles, of which about 1,860 square miles lie in the United States.

That part of the river, about 75 miles, which lies in the United States is wholly in Okanogan County, in the State of Washington. It flows through a narrow valley in the midst of hilly or mountainous country. In places the hills rise from the water's edge, but for the most part there is a narrow strip of lowland along the river bank, widening in places to a mile or so, and for 10 miles south of Okanogan Lake having a width of 2 to 3 miles.

About 8 miles south of the boundary the Okanogan is joined by the Similikameen, a rapid stream flowing from the northwest, which appears to contribute as much water as the Okanogan above the junction. Besides this, there are numerous small tributary streams or creeks flowing in from the hills on either side.

The total fall of the river from Osoyoos Lake to the Columbia, a distance of 75 miles, is about 80 feet. The river is made of a series of quiet reaches a mile or so in length, separated by ripples, mostly insignificant. The least depths are at these ripples. The bottom is stony, gravelly, and sandy.

The average width of the river is 200 to 300 feet.

There is one high water per annum—in the spring. The lowest stage is in November, December, and January. The highest ordinary stage is about 10 feet above the lowest. The river rarely overflows its banks, which at their lowest points are 12 feet or so above low water. During exceptional freshets there have been local overflows.

I inspected the river personally from its mouth to Osoyoos Lake, and got what information I could from steamboat men familiar with it, and from inhabitants of the country. The river was less than 1 foot above its lowest stage. So far as I can see, there is only one real obstruction in this portion of the river. This is McLaughlin Falls, about 45 miles above the mouth and 30 miles below Osoyoos Lake. Here the water is dammed up by a rocky reef, so that its slope in escaping is very steep. The falls are not falls, properly speaking, but steep rapids, having a fall of about 6 feet at low water. The river is about 60 yards wide, and is divided, at low water, by a mass of rock in the middle. Were it not for obstructing rocks I think that a steamer could line up at ordinary stages.

The falls are situated in a loop of the river, the neck of which is not more than 200 yards across. This neck is submerged at high water.

There appears to be no obstruction at all between McLaughlin Falls and Osoyoos Lake, and there is no real hindrance to navigation between the falls and the mouth. The worst obstruction in this lower stretch is Guthrie Rapids, about 35 miles above the mouth. Here are three or four troublesome rocks and a total fall of 2 or 3 feet in two principal ripples.

The steamer *City of Ellensburg*, which runs between Wenatchee and Virginia City, has made a number of trips up the Okanogan in the spring and early summer of the

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* Not sent.

last two years. She carried supplies to the settlers. The *Ellensburg* is said to draw 4 feet loaded, and is rather too big a boat for the Okanogan. She once ran up as far as McLaughlin Falls without difficulty, but regularly ran only as far as Alma, about 25 miles above the mouth. Captain Danaher, who commanded the *Ellensburg* at that time, kindly furnished me with a pilot's chart of the river, showing all the difficult places below McLaughlin Falls. A copy of the chart * is submitted herewith. It is for a stage about 1 foot above low water. The least depth at this stage is 3 feet, and this depth occurs only in six places. I think that a small steamer drawing 18 inches or 2 feet could easily navigate the river from the mouth to the falls during the greater part of the year.

No attempt has been made to navigate the Canadian portion of the river. It is said to be swifter and more obstructed, and to have less water.

The country adjacent to the Okanogan River is very rough and hilly, becoming mountainous toward the north. The valley of the river is very narrow, as before remarked. Numerous small tributary streams flow through deep narrow canyons with a strip of arable land at the bottom. There are a great number of small lakes, especially in the northern part.

The higher altitudes are fairly well timbered, chiefly with pine. The lower hills are mostly covered with bunch grass. There is a great deal of bare rock visible. The rock is mostly eruptive, and very hard. There are outcrops of limestone.

The country is very dry and dusty; alkaline dust abounds. Rain is infrequent, although a good deal of snow falls in winter.

The river forms the western boundary of the Colville Indian Reservation. This reservation formerly extended to the Canadian frontier, but that portion lying north of a line 36 miles south of the international boundary has been recently taken away and will soon be opened to settlement.

The white population of the country is all on the west side of the river. This population is hard to estimate, as it is scattered, and to some extent fluctuating. It is possibly 2,000. There are five towns whose positions are indicated on the map: Virginia City, Ruby, Conconully, Loomiston, and Oro.

Virginia City, on the Columbia, is a collection of half a dozen houses. It is the present terminus of the steamboat line on the Columbia River. It has a general store, and a hotel is projected. Virginia City is the northern terminus of the steamboat line running on the Columbia from Wenatchee, a station on the Great Northern Railroad.

Ruby, the next town above Virginia City to the north, is 36 miles by road from that place. It was formerly a prosperous mining town with several hundred inhabitants. Since the decline of silver the population has shrunk to several dozen. It has a store, a hotel, a fine school building, and about one hundred dwelling houses.

Conconully is the county seat of Okanogan County. It is situated at the bottom of a deep valley, beside a beautiful lake, and was half destroyed last spring by a flood, caused by a cloudburst in a neighboring gorge. Its present population is 200 or 300. There are a large general store, several saloons, a court-house, a schoolhouse, a good hotel, livery stable, and blacksmith shop. There are several lawyers located here.

Loomiston is a town of 150 to 200 people. It has two hotels, a store, several saloons, and a livery stable.

Oro is well situated at the junction of the Okanogan and Similikameen rivers, on a level plain. It has a population of about 100; two hotels, a store, and saloons.

Between Loomiston and Oro is the sometime town of Golden, with 50 or 60 houses and 5 or 6 inhabitants. The other towns indicated on the map have only an imaginary existence.

All the towns named are on the stage road, which is the only means of communication with the outer world. This road runs from Coulee City, the terminus of the Central Washington Railroad, to Penticton, at the foot of Okanogan Lake, in the Dominion of Canada. It strikes the Columbia River at Bridgeport, a town site on the south bank about 7 miles above the mouth of the Okanogan. There is a fine hotel at Bridgeport, a saw and flour mill, and about two dwellings.

At Bridgeport, the road divides; one branch crosses the Columbia by ferry, goes across the southwest corner of the reservation, and crosses the Okanogan by ferry 7 miles above its mouth. The other runs along the south bank of the Columbia and crosses it by ferry at Virginia City. These branches reunite at Ophir post office, 10 miles above the mouth of the Okanogan. The road leaves the Okanogan near Alma, and runs up the canyon of Salmon Creek to Ruby. It strikes the river again at Oro.

There is a fairly good wagon road along the west bank of the river beyond where the stage road branches off, and a number of crossroads.

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* Not sent.

The distances along the stage road are as follows: Coulee City to Bridgeport, 48 miles; Bridgeport to Virginia City, 10 miles; Bridgeport to Ruby, 44 miles; Ruby to Conconully, 6 miles; Conconully to Loomiston, 20 miles; Loomiston to Oro, 22 miles; Oro to Penticton, 40 miles. From Penticton, a steamer runs up Okanogan Lake to Vernon, the terminus of a branch of the Canadian Pacific.

Passenger rates are as follows: Coulee City to Conconully, $10; Virginia City to Conconully, $5; Conconully to Oro, $4; Oro to Penticton, $5.

A ton of freight costs about twice as much as one passenger, but most of the freight is hauled by private teams. From Virginia City to Wenatchee on the boat, the rate is $5 per ton. Scarcely any freight comes across from Canada, because of the customs duties.

The Okanogan country is important chiefly because of its mineral deposits. These are in the upper portion, near the towns of Ruby, Conconully, Loomiston, Golden, and Oro.

Near Ruby are the Chloride and Ruby Hill silver districts. The Ruby Hill mines were worked for about three months last year, but shut down because of the decline in silver. The ore was concentrated at the Ruby mill, and in the form of concentrate shipped by wagon, at $20 per ton, to Coulee City, and thence by railroad, via Spokane, to Tacoma, where it was reduced and refined. After the fall in price the freight charges ate up the profits.

At Conconully are the Mineral Hill silver mines, which have been only partially developed; and east of Conconully toward the river are the Lime Belt and Pine Creek districts, not developed at all.

Between Loomiston and Oro are extensive gold and silver deposits, known as the Palmer Mountain and Wanicott Lake mines, as yet almost untouched; and southwest of Loomiston are the Mount Chapaca gold and silver mines, said to be rich but quite undeveloped. The country soon to be opened east of the river is said to be equally rich. Copper is said to occur near Osoyoos Lake.

Attempts have been made to work a number of these mines, notably at Conconully and about Golden, but they were not successful, and no work is now being done except at small placer mines along the streams. Specimens from many places assayed very well, but there was lack of capital, and transportation was very difficult, so that the recent hard times brought everything to a standstill before it was fairly begun.

Apart from mining, the chief resource of the country is stock raising. Many of the lower hills, being covered with bunch grass, are excellent for stock, and there are several large cattle ranches. The chief market is found in the Sound country, the cattle being driven across a mountain trail.

General farming for home consumption is carried on in the lowland adjacent to the river and along the creeks. Much of the light sandy soil is excellent for fruit, where water can be had, and in a few places irrigation is resorted to, but the fruit business also suffers for lack of transportation.

Most of the food supply is raised in the vicinity. Flour is mostly brought from the mill at Bridgeport. Other supplies are brought in by wagon, either from Virginia City or from Coulee City—chiefly the latter.

I regard McLaughlin Falls as the only serious obstruction to the navigation of the river. I am likewise of opinion that the river at this point can easily be improved to such an extent that suitable boats can go up. Whether the resulting benefit to commerce would justify the expenditure, is another question.

I think there is no doubt that the upper part of the Okanogan country is rich in gold and silver, and that it will probably be developed in the near future. At present nothing is going on and there is no commerce to speak of, but this condition of things is probably transitory. It is to be observed that the mining districts and consequently the population is almost wholly above the falls, so that the navigation at present possible is not of great benefit.

I am of opinion that the Okanogan River is worthy of improvement to the extent of forming a navigable channel at McLaughlin Falls, and perhaps blasting out a few rocks elsewhere.

A survey of the river would cost about $1,000.

Very respectfully, your obedient servant,

FRANCIS R. SHUNK,
First Lieutenant, Corps of Engineers.

Capt. T. W. SYMONS,
Corps of Engineers.

T T 29.

PRELIMINARY EXAMINATION OF FLATHEAD RIVER, FROM COLUMBIA FALLS, IN MONTANA, TO ITS MOUTH AT FLATHEAD LAKE, AND FROM ITS OUTLET ON THE SOUTH AT FLATHEAD LAKE TO THE CLARKES FORK OF THE COLUMBIA RIVER; AND OF PEND D'OREILLE RIVER, FROM FLATHEAD LAKE TO JOCKO STATION, MONTANA.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., August 5, 1895.

GENERAL: I have the honor to submit the following report upon the Flathead and Pend d'Oreille rivers as required from me by your letter of August 20, 1894.

This letter required me to make a preliminary examination of—

> Flathead River, from Columbia Falls, in Montana, to its mouth at Flathead Lake, and from its outlet on the south at Flathead Lake to the Clarkes Fork of the Columbia River.

and of—

> Pend d'Oreille River, from Flathead Lake to Jocko Station, Montana.

The last item is included in the first, and its insertion as a separate item is probably due to a confusion of names of the rivers in this section.

The name Flathead should apply to the river above the Flathead Lake, and below the lake to the point where it unites with the Missoula. From this point it becomes the Clarkes Fork of the Columbia, or Pend d'Oreille River.

The following general description of the country and the situation as regards transportation routes and the commercial relations of the various sections of Montana are given as far as they bear upon the question at issue.

Montana is made up very largely of mountains and of plains suitable only for grazing purposes. The chief industry of the State is mining. The agricultural sections of the State are few in number and limited in area. The Flathead country to the north of the Flathead Lake is one of the best and largest of these agricultural sections. It is an exceptionally fine, rich, well-watered country in the northwestern corner of Montana. The main range of the Rocky Mountains forms its eastern boundary and the Kootenai Range the western. It comprises prairie lands, timber lands, bench lands, and lowlands. The general elevation of the valley is 2,500 to 3,000 feet above sea level.

The valley produces very fine crops of nearly all the cereals, hardy fruits, hay, vegetables, berries, etc. Great areas of fine timber land form part of this valley. The surrounding mountains are rich in coal, iron, and precious metals.

The principal drawback to the development of the country is the lack of a market for its agricultural and lumber products.

A market exists in the southern portion of the State in the mining regions about Helena, Butte, Anaconda, Virginia City, etc., for all the products of the valley, but there is no direct and easy route for getting them there.

The Great Northern Railroad runs through the valley, and the only way to go south by rail is by a wide detour either westward to Spokane and thence east on the Northern Pacific, or to go eastward to Shelby Junction, and thence south by the Great Falls and Canada and Montana Central railroads.

If a water route could be opened down the river and lake to the Northern Pacific at Jocko Station, it would be the shortest practicable route between the valley and its home market in the southern Montana mining regions.

It is this water route between the two transcontinental railroad lines of the Great Northern and Northern Pacific that the people of Montana want, and it is very desirable that they should have it, and it is therefore with very great regret that I am compelled to report that it is impracticable to obtain it, as the difficulties in the way of making a commercial watery highway down the Flathead River are of such a stupendous nature as to render the stream unworthy of improvement by the General Government.

On one portion of the river, which is at present navigated, a little work could be advantageously done in removing bothersome snags, but aside from this the river is considered to be unworthy of improvement.

For purposes of discussion in this report, the entire water course included in the language of the act may be divided into four parts:

1. From Columbia Falls to Demarsville, about 16 miles in length.
2. From Demarsville to the Flathead Lake, about 27 miles in length.
3. From Flathead Lake to Jocko Station, Mont., about 40 miles in length.
4. From Jocko Station to the Clarkes Fork of the Columbia, about 25 miles in length.

First section, Columbia Falls to Demarsville.—Columbia Falls is a small town of about 150 inhabitants situated on the line of the Great Northern Railroad and on the Flathead River, a little below where the North, Middle, and South forks unite. The name of the town is a misnomer, as there are no falls there. From Columbia Falls to Demarsville, a distance of about 16 miles, the river has always been considered unnavigable owing to its swift, powerful currents and the multiplicity of shallow and changeable channels into which it divides.

Two close bridges have been built across the river, one just below the town of Columbia Falls and one about 3 miles above Demarsville. The river is paralleled by the Great Northern Railroad in this portion of its course.

If the river were to be considered navigable and its improvement be undertaken it would be necessary to change these bridges by raising them or putting in draws. This would entail a burden upon the people which would be greater than the benefits which they would derive from any practical change in the navigable capacity of the river.

I could not ascertain that there was any real demand for the improvement of this portion of the river or expectation that it would be improved. This portion of the Flathead River is therefore considered unworthy of improvement by the General Government.

Second section, Demarsville to Flathead Lake.—Demarsville is situated on the Flathead River, about 27 miles up from the lake. It is about 3 miles from the town of Kalispell, the principal commercial town of the valley.

Before the advent of the Great Northern, Demarsville was the principal town of the valley, having been established at what was considered the head of navigation. The river from here to the lake is of very gentle slope, running with many turns through a large area of low-lying lands. It might in reality almost be considered an arm of the lake. There are two steamers on this portion of the river, which also run through to the foot of the lake. One, the *Montana*, is 160 feet long and 26 feet beam; the other, the *Kalispell*, is 82 feet long and 15 feet beam. Both are stern-wheelers.

From Demarsville to the lake the minimum depth of the river is probably 10 feet, and the only obstructions to free navigation consist of numbers of snags which have accumulated in the river.

The removal of the dangerous snags from this portion of the river would be of benefit to navigation and would not be very expensive.

To this extent I regard the portion of the Flathead River from Demarsville to the Flathead Lake as worthy of improvement by the General Government.

No survey is necessary. An estimate of the cost of the work can be made as well now as after a survey. The snags are constantly changing in position and number, and a survey would be no guide to the condition of the river months or years afterwards.

The business on the river consists in supplying the local demand of the settlers along the river for transportation, carrying themselves, their products and supplies to and from market, and in conveying passengers and freight from Demarsville to the foot of the Flathead Lake, there to connect by stage and wagon with the Northern Pacific Railroad at Ravalli Station. I could obtain no accurate statistics of the business done on the river, as no account of it is kept.

Third section, Flathead Lake to Jocko Station.—This portion of the river is entirely within the limits of the Flathead Indian Reservation. There is no local demand for its improvement, but the demand is entirely due to the desire of the people of the upper valley to have a through, short water route by which they can ship their products to the line of the Northern Pacific Railroad, and thence to market in the mining camps and towns of southern Montana.

An examination of the river, however, shows that it is utterly impracticable to give the desired relief, as its cost would be so stupendous as to be incommensurate even with the great benefits which it would confer.

From the foot of the lake to Jocko Station the river is, approximately, 40 miles long, and in this distance the fall is about 420 feet.

Some years ago the Northern Pacific Railroad Company made a survey for a branch from Jocko to the lake, and this survey showed a fall of 419 feet in this distance.

Aneroid observations taken by me showed a fall of 400 feet. Comparisons of the Great Northern levels at Kalispell with the Northern Pacific levels at Jocko show a fall in river and lake in this distance of 461 feet. It is therefore fair to assume that the fall from the lake to Jocko is 420 feet, or an average of 10.5 feet per mile.

The greater portion of the fall is in 3 miles of the river's course near the lake. In these 3 miles the fall is, approximately, 220 feet, or 73 feet to the mile.

For the first mile of its course from the lake the river runs through open country with a strong, rapid current unbroken by any obstructions. About a mile from the lake the river enters a rocky canyon, through which it flows for about 3 miles. This canyon is from 300 to 500 feet deep, and the banks are so steep and rugged that it is impassable near the water.

Through the canyon the river runs in a most turbulent course, the total fall of about 220 feet being made up of falls and foaming rapids and stretches of smooth, swift-running water. The falls divide themselves into four groups—Upper, Middle, Fisheries, and Lower falls. The most marked of these is the Fisheries Falls, where the river narrows in between vertical walls of rock to a width of not much over 100 feet. On the right bank of the river the wall of rock is straight for about 400

feet in length and nearly 300 feet in perpendicular height. The rock is shale and is surmounted by a clayey formation which in places has been chiseled by the elements into beautiful cathedral forms.

The total fall through the canyon, as determined by aneroid, is 220 feet, divided about as follows: Upper Falls, 60 feet; Middle Falls, 40 feet; Fisheries Falls, 60 feet, and Lower Falls, 60 feet.

For about 2 miles below the foot of the Lower Falls the river runs with great strength and swiftness, though unbroken by rocks or falls. From this point to Jocko there is a much gentler current, and it is believed that a boat with fair power would have no difficulty in traversing it. The following table indicates the approximate profile of the river:

	Distance.	Fall.
	Miles.	*Feet.*
Lake to head of canyon	1	10
Upper Falls	3	60
Middle Falls		40
Fisheries Falls		60
Lower Falls		60
Below falls	2	20
To Jocko	34	*170
Total	40	420

* Average fall per mile, 5 feet.

Any scheme of improving the river to give continuous navigation for boats must provide for raising them artificially at least 200 feet through the canyon hereinbefore mentioned. A canal around the falls is impracticable, and a series of locks and dams would be required. At least 10 of these would be required, with an average lift of 20 feet.

The cost of these locks and dams in such a river and canyon, far removed from centers of population and supplies, would be enormous. The maintenance of such a series of locks would also be very expensive.

It is quite certain that a railroad from Jocko to the lake could be built and operated and all passengers and freight transported free at a less cost than would be the cost of putting the river in a navigable condition and so maintaining it.

I am, in view of the above facts, therefore compelled to report that, in my opinion, the Flathead River from Flathead Lake to Jocko Station, Mont., is unworthy of improvement by the General Government.

There can be no doubt that in the near future a line of railroad will be built from the lake to some point on the Northern Pacific, which will give the desired transportation route to the Flathead Valley.

Fourth section, Jocko Station to the Clarkes Fork of the Columbia.—This portion of the river runs through a narrow valley, nearly all of which is in the Flathead Indian Reservation. The Northern Pacific Railroad runs along its left bank, crossing it near its mouth on a close bridge. The river is fairly well suited to navigation now, but there is no use made of it, and as far as I could determine there is no occasion for its use as a navigable highway nor any demand for its improvement by any individuals or interests.

Therefore I report that this portion of the Flathead River, from Jocko Station to the Clarkes Fork of the Columbia, is unworthy of improvement by the General Government.

To summarize, I would state that, in my opinion, the Flathead River from Demarsville to Flathead Lake is worthy of improvement by the

General Government to the extent of removing troublesome snags, and that all other portions of the river from Columbia Falls to the Clarkes Fork of the Columbia are unworthy of improvement.

I inclose herewith a map* of northwestern Montana, which shows the Flathead River and lake and their general surroundings.

The following statistical information was furnished me by Mr. George E. Stannard.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through Col. G. H. Mendell, Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., August 14, 1895.

Respectfully forwarded.

For reasons stated herein, Flathead River, so far as it lies between Demarsville and the lake, is worthy of improvement to the extent of removal of snags.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

COMMERCIAL STATISTICS.

Area of county, 8,848.5 square miles outside of reservation, 570 square miles inside of reservation; total, 9,418.5 square miles. This county is about 300 square miles larger than Massachusetts and Rhode Island combined.

Assessed valuation.

	Acres.
Land assessed in county, 1894	95,820
Northern Pacific land assessed	36,000
Patented since 1894	3,800
Total	135,620

The State University has 17 sections of land rented, but not assessed; also school sections and all Government lands not as yet patented are not assessed.

University State lands cultivated in county, 1[illegible]4,000 acres.

There are 54 townships (whole and fractional) surveyed in the county, the assessed valuation of which, although small, is increasing rapidly. In 1894 it was $2,946,000; in 1895, $3,200,000.

Lumber.—It is estimated that there are, allowing only 5,000 feet of lumber per acre, 26,870,000,000 feet of lumber tributary to Flathead Lake, which is a magnificent sheet of water 35 miles long and 10 miles wide, containing about 350 square miles.

There are about 700 miles of logging streams tributary to the Flathead Lake, along which grows a fine quality of white pine, yellow pine, black pine, lodge-pole pine, tamarack, fir (balsam), fir (red), hemlock, cedar, spruce, birch (white), and cottonwood lumber.

Population.—Population of county, 1895, about 10,925. Population of Kalispell (county seat), 1895, about 2,500, and increasing rapidly.

Shipments.—From October 1, 1894, to June 29, 1895, there were shipped from the valley 927 carloads of products, containing 35,070,292 pounds, nearly all of which would go south to the Montana markets if the waterway was opened up.

General.—The distance from Kalispell to Helena, the State capital, is, via Spokane or Great Falls, 500 miles; via river, lake, and Jocko, 269 miles, making a difference of 231 miles.

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*Omitted.

There are 15 sawmills and 3 flour mills in the county.

The post-offices between Kalispell and Jocko are Demarsville, Holt, and Dayton Creek, and we would receive our Montana mails at least twelve hours sooner if the waterway was opened up.

Steamers are already built to navigate the streams.

T T 30.

PRELIMINARY EXAMINATION OF NORTH RIVER, WASHINGTON, FROM ITS MOUTH IN WILLAPA BAY UPWARD TWENTY-FIVE MILES.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., April 23, 1895.

GENERAL: In accordance with instructions contained in your letter of August 20, 1894, an examination has been made of "North River, Washington, from its mouth in Willapa Bay upward 25 miles," and the following report is submitted in relation thereto:

North River is a tributary of Willapa Harbor. It rises in the Coast Range of mountains and flows in a general northwesterly course for half its length, and then in a southwesterly direction to its outlet. Its drainage area is about 432 square miles.

The country through which the river flows is hilly, with comparatively narrow bottoms along it and its tributary streams. These bottom valley lands vary in width from one-half to 3 miles, and are very rich and fertile. The whole drainage area, with slight exceptions, is covered with a very rich growth of the finest timber, principally of fir and spruce.

The land, when cleared of its timber, is agricultural land of the highest excellence.

There are some 250 families in the valley who depend for a living upon agriculture and labor in the woods.

An open river is very desirable and necessary for these hardy pioneers for two reasons—to enable them to market their lumber and logs and clear off their land for agricultural purposes, and to enable them to get supplies into the country at a reasonable rate. The expense of opening up the river for the lower 25 miles of its course to the extent of making it suitable for floating logs and lumber, and for traversing with light-draft boats, it is believed, will not be very great.

The density of the forests and the forest jungles and the great rainfall in this region render the building and maintenance of wagon roads exceedingly difficult and expensive and add to the importance of the water highway of the river.

It is estimated that there are some 4,000,000,000 feet of merchantable timber tributary to the river.

From the facts above enumerated, I am of the opinion that the North River from its mouth for 25 miles upward is worthy of improvement by the General Government.

In this portion of the river there are two quite serious obstructions to navigation.

The first obstruction met with is 14 miles above the mouth of the river at the head of tide. Here there is a fall at low water of about 8 feet. The tide here has an ordinary rise of about 6 feet. This fall is caused by a soft rocky ledge extending across the river. It is believed that by removing sufficient of this rock ledge, the river can be greatly benefited and put into a condition which will be satisfactory for a long time to come.

The second principal obstruction is a big jam of timber in the river about 5 miles above the falls just mentioned. This jam completely blocks navigation at all seasons of the year, preventing even the running of logs. The length of the jam is about 3,000 feet.

Under the provision of the last river and harbor bill $2,500 was made available for removing this jam, and a contract has been let for making an open channel 50 feet wide through it.

This width of 50 feet is not sufficient for all purposes, and unless it is removed to a greater width it is liable to be blocked up again.

Besides the above there are several riffles where the water runs swiftly over soft rock ledges. If practicable the river should be improved at these points. Just what can be done can only be determined by a careful survey.

It is estimated that a survey of the river from its mouth for the first 25 miles of its course will cost $750.

The examination of the river was made by Mr. J. M. Clapp, assistant engineer. Mr. Clapp started in a small boat and traversed the river from Brooklyn to its mouth, a distance of 54 miles. His report, which is herewith, includes the facts relative to this whole portion of the river.

A map of the river is herewith.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. G. H. Mendell, Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., April 26, 1895.

Respectfully forwarded to the Chief of Engineers.

For reasons herein given, North River is considered to be worthy of improvement.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. J. M. CLAPP, ASSISTANT ENGINEER.

HOQUIAM, WASH., *March 30, 1895.*

CAPTAIN: I have the honor to respectfully submit the following report of an examination of North River, Washington, from a point 10 miles from its source to its mouth, made in March, 1895.

The examination, covering a distance of about 54 miles by the river, was made from a rowboat.

I was informed on good authority before I entered the North River Valley that no boats suitable for this trip could be obtained on the river. I therefore had a small boat conveyed over the mountains from Willapa City, a small town on the Willapa River, to Brooklyn, at the junction of North River with Fall River, one of its tributaries.

The boat, which weighed about 200 pounds, was hauled on a sled drawn by a team of horses over a very rough and muddy road, crossing, about 6 miles north of Willapa, a divide, the elevation of which, as indicated by barometer, was about 1,100 feet above sea level. The journey overland was made in seven hours.

Brooklyn is distant from Willapa about 13 miles, and from Cosmopolis on the Chehalis River, a tributary of Grays Harbor, about 30 miles.

The examination was made starting at Brooklyn and working downstream. The boat was dragged over or around the jams of logs obstructing the channel of the river.

North River is one of the principal tributaries of Shoalwater Bay, or Willapa Harbor, which it joins in township 14 north, range 10 west of the Willamette meridian. Its junction with Willapa Harbor is near the mouth of Willapa River, its channel there at low water being about 600 feet wide and bounded on either side by low mud flats. The direction of North River at its junction with Willapa Harbor is nearly south.

The source of the river is in the Coast Range of mountains, its head waters being near those of the Chehalis River and its tributaries, but on the opposite side of the divide.

Throughout its course the river is joined at short intervals by good-sized creeks which appear to be deep and sluggish and drain tributary valleys, which I am informed are very fertile and contain an abundance of the finest kind of fir and spruce timber. The general direction of the river is northwest from its source to Artic, about 21 miles above the head of tide water, and southwest from Artic to its mouth.

Between Willapa Harbor and the head of navigation at the falls (shown on the accompanying tracing), 14 miles above the mouth, navigation is safe at high tide for boats drawing 10 feet of water.

At the falls navigation is obstructed by a fall, the height of which I judge to be about 8 feet at low water Tide water, which reaches to the root of this fall, has an estimated fluctuation of 6 feet. At the falls bluffs of soapstone flank the river on each side.

The depth of water immediately above the falls is estimated at from 8 to 10 feet; that immediately below at about 5 or 6 feet.

The width of the river at the falls is about 135 feet. This increases gradually to about 250 feet at Smith Creek, near the mouth of the river.

The length of the shallow water at the falls is about 200 feet. The depth over this in summer is only a few inches, except in a very crooked channel, where, I am told, it is from 4 to 6 feet.

I have been informed by the people who live near this point that the depth of water pouring over the falls during a freshet is about 8 feet, with a velocity estimated at from 8 to 10 miles per hour.

Above the falls the river, for a distance of about half a mile, is deep and sluggish.

The line between Pacific County on the south and Chehalis County on the north, crosses the river on this reach. At the head of this reach is Canoe Riffle, and between it and the Big Jam, situated about 5 miles above the head of tide, are Widows, Sawlog, Beebes, Dutchmans, and Soapstone riffles, the approximate location of which are shown on the accompanying tracing. At each of these riffles a soapstone bluff is found close to the river on one side or the other.

The riffles are all similar in character. Each consists of a bar, presumably of soapstone, covered with about 1½ feet of water at the low stage, through which is cut a channel 15 to 20 feet wide, having a depth of water of 2½ to 4 feet.

The reaches of river between the riffles are deep, the current over them is sluggish, and the velocity at low water from one-half to 1½ miles per hour.

The next obstruction, and perhaps the most aggravating one, is the Big Jam, which completely blocks navigation for even a canoe at all seasons of the year. This jam is composed of an accumulation of heavy trees, logs, roots, and drift of all descriptions, which probably has been gathering for years past.

This jam occupies about 3,000 feet of the length of the river. On this length the aggregate length of open water, which occurs in two places, is about 800 feet, reducing the actual length of obstructed channel to about 2,200 feet.

Between the Big Jam and a point one-half mile below the head of tide the river passes through a narrow valley about 400 feet wide, flanked by mountains, the height of which do not exceed 1,000 feet. Above the Big Jam, as far as the Little North River, the valley has a width varying from one-quarter to 1½ miles, and above the latter point a width varying from one-half to 2½ miles. About 2 miles above the mouth of Little North River is Artic, distant about 21 miles above the head of tide.

Between Big Jam and Artic are Hayes, Deering, Stump, and Preachers riffles. At each of these riffles is found on one side of the river a bluff of soapstone. These riffles are similar in character. They consist of soapstone bars from 20 to 70 feet long, covered with about 1 foot of water at the low stage, through which is cut a channel 15 to 20 feet wide having a depth of water of 2½ to 3 feet. Above and below the riffles the river is deep and sluggish. The width of the river from Artic to the Big Jam is nearly uniform and averages about 100 feet; between the Big Jam and the falls below the average width is about 120 feet.

Between Artic and Brooklyn the obstructions consist of ten small jams of trees, logs, and other driftwood. They vary in length from 30 feet to 700 feet, and appear to be of recent accumulation. I am of opinion that they settle with each freshet farther downstream. They are shown on the accompanying tracing as Jam No. 1, No. 2, etc.

Some of the settlers are now engaged in dislodging some of these jams in order that they may be able to use portions of the river as a highway.

A bridge crosses the river at a narrow place at Mr. Bennett's place, about 1 mile above Artic. The span of the bridge is 64 feet and the height of roadway above low water is about 34 feet.

About 4 miles above Artic and in section 27, township 16 north, range 8 west, there is a fall of 3 feet at low water The river here is flanked on the south side by a soapstone bluff. The river bed at this fall is similar in character to that at the riffles, and has a narrow, crooked channel about 15 feet wide, carrying a depth of water of about 4 feet.

About one-fourth mile above this fall and in the same section is another riffle similar in character to those heretofore described. The obstructions above enumerated were all that I observed during this examination. It is possible, however, that a more careful examination will lead to the discovery of other riffles of lesser importance.

The area drained by North River and its tributaries is about 432 square miles, or 12 townships. This drainage area is greater than that of the Willapa River, the latter being about 288 square miles, or eight townships.

From Brooklyn to tidewater North River is a sluggish stream. At the former place it is about 50 feet wide. In its descent it winds tortuously through the alluvial bottom between banks 12 to 20 feet high, frequently striking soapstone bluffs 50 to 100 feet high. During high water the river overflowing its banks and inundating the bottom lands spreads out to a width of from 400 to 1,000 feet.

The freshet rise at Brooklyn is about 30 feet; at Artic about 25 feet; at the Big Jam, about 20 feet, and at the head of navigation at the falls, from 8 to 10 feet. The duration of this rise is seldom longer than twenty-four hours, after which the river is confined to its normal banks. During the months of July, August, and September the water is lowest. The average depth at that time, except at the riffles, is between Brooklyn and Vesta, about 5 feet; between Vesta and Artic, about 7 feet and between Artic and the head of navigation, about 10 feet. From October until June the water is generally more than 6 feet above low water. The riffles and the falls in section 27, township 16 north, range 8 west, then disappear.

This year, I have been informed, has been an exceptional one, the water at the time the examination was made being almost as low as it is during the summer months.

The valley drained by the North River is very rich and fertile. A great portion of it, especially that along the river bottom, is more valuable for agricultural purposes than for the timber which grows on it. The timber which grows on bottom land is scrubby spruce, and some fir, a great deal of alder, and some willow.

The uplands flanking the valley are covered with an abundance of the finest kind of timber. Toward the mouth of the river the timber is spruce; the trees are of large diameter and reach to a great height. In the upper part of the valley the preponderance is fir, a great portion of which is about 4 feet through at the butt of the tree and free of limbs for a great height. This timber will make the finest kind of ship spars.

Mr. George H. Emerson, resident manager of the Northwestern Lumber Company at Hoquiam, Wash., who has recently made a personal reconnaissance of the hills and valleys tributary to North River, estimates that there are about 270,000 acres tributary to the river. He reports that some of the sections he passed through would cut 100,000 feet of lumber to the acre.

Estimating the cut at an average of 15,000 feet per acre (which is probably a low estimate), this area would furnish over 4,000,000,000 feet of lumber, a quantity adequate to supply a mill of 150,000 feet average daily capacity for nearly one hundred years.

I have been informed that the soil of both hills and valleys is very choice, and that when the timber is removed the land is excellent for agriculture.

Settlers in the valley, of whom there are about 250 families, aggregating a population of about 500, are engaged in clearing land and making homes for themselves. Much fine timber has thereby been destroyed. The land, when cleared, is seeded with grass so as to provide pasturage for stock, or otherwise cultivated. Some of the settlers have been in the valley over nine years and have upward of 50 acres under cultivation. Some of the settlers make a good living by raising stock, dairy produce, and chickens, though the majority of the male population are obliged to seek work outside of the valley for a few months to enable them to buy such needed supplies as their farms do not produce.

NORTH RIVER, WASHINGTON.

SHOWING OBSTRUCTIONS TO NAVIGATION.

Compiled from U.S. Land Office plats, and from Examination made in March 1895, by J.M. Clapp, Assistant Engineer.

To accompany report of Capt T. W. Symons, Corps of Engineers, of April, 1895

Scale

Mile 1 3/4 1/2 1/4 0 1 2 3 Miles

Examination authorized by River and Harbor Act of Aug. 17th 1894.

Drawn by A. Downing

Eng 54 1

Communications.—Roads, which during the summer months are fairly good, but which during the remainder of the year are very poor, furnish to the settlers of the valley the means of communication with the Grays Harbor country and Willapa City. Mail is brought in on horseback from Willapa on Monday and Friday of each week, supplying the post-offices of Brooklyn, Vesta, and Artic. Returning, the mail leaves these post-offices for Willapa on Tuesday and Saturday. Mail is also brought in from Montesano to Artic twice a week, and is carried back again on the days following its arrival at Artic.

Canto, a post-office situated about a mile below the falls, is supplied with mail from South Bend two or three times a week.

The divide between the Grays Harbor Valley and the North River Valley is, I am informed, about 400 feet in elevation. North River is nearest to Grays Harbor at Artic, which is distant from Cosmopolis about 10 miles.

Supplies for settlers in the upper valley above Vesta are brought from Willapa by pack animals or on sleds. Supplies for settlers in the middle valley, between Vesta and the Big Jam, are brought from Cosmopolis and Montesano on the Chehalis River. The cost of transportation in both cases is $20 per ton.

Settlers of the lower valley are more fortunate. Their supplies are received from South Bend on Willapa Harbor, the cost of transportation ranging from $4 to $7 per ton.

Barometric observations.—During the progress of the examination, elevations, as indicated by pocket aneroid, were noted. These after correction by comparison with readings at South Bend, which were made daily at 8 a. m. and 5 p. m., gave the following results:

	Feet.
At Brooklyn, 43 miles above tide water (above sea)	80
At Artic, 21 miles above tide water (above sea)	36
At Big Jam, 5 miles above tide water (above sea)	15

Commercial statistics.—The imports are such domestic supplies as are needed by the settlers, and a very limited amount of tools and building material. The whole amount probably does not exceed 500 tons, valued at about $5,000 in any one year.

The exports consist of chickens, butter, eggs, potatoes (which grow well and yield heavy crops), fat cattle, and bacon; in all, probably not to exceed 250 tons, valued at about $3,000.

Improvements.—The improvements necessary to make the river navigable are the removal of the ten small jams which aggregate in length 2,630 feet, and of a part of the Big Jam, throughout a length of about 2,200 feet, and to this extent I believe the river is worthy of improvement.

The benefits derived from such an improvement will be the opening up to settlement of a very large and valuable timber and agricultural country, by furnishing an avenue to market for logs and agricultural products and intercommunication between distant parts of the valley.

It is difficult to give any intelligent estimate of the cost of the required improvement from the data now at hand. I therefore recommend that a survey of the river from the falls to Brooklyn be made. Such a survey will develop other data of value, and will cost about $1,500.

Respectfully submitted.

Your obedient servant,

J. M. CLAPP, *Assistant Engineer.*

Capt. THOMAS W. SYMONS,
Corps of Engineers, U. S. A.

T T 31.

PRELIMINARY EXAMINATION OF KOOTENAI RIVER FROM JENNINGS, IN MONTANA, TO THE INTERNATIONAL BOUNDARY WITH A VIEW OF REMOVING ROCKS AND OBSTRUCTIONS IN THE CANYON ABOVE THE TOWN OF JENNINGS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., August 5, 1895.

GENERAL: I have the honor to submit the following report on the preliminary examination required by your letter of August 20, 1894, of "Kootenai River from Jennings, in Montana, to the international

boundary with a view of removing rocks and obstructions in the canyon above the town of Jennings:"

Jennings is a small town and station on the Great Northern Railroad and on the Kootenai River. It is situated at the point where the river, flowing to the south from British Columbia, turns abruptly to the west. It is at this point that the Great Northern on its way east leaves the river and crosses the Haskell Pass to the Flathead Valley.

It is my opinion that the Kootenai River from Jennings to the international boundary line is worthy of improvement by the General Government to the limited extent outlined in the law.

The country through which this portion of the Kootenai flows is generally mountainous and timbered, and traveling is impracticable except by water or a difficult mountain trail. Along the left bank of the river and just south of the international boundary line is a very considerable area of fine agricultural land known as Tobacco Plains. This country has probably at present 250 people engaged in farming, and to a great extent they depend upon getting their supplies in from Jennings by the river; and also they depend upon marketing their products in the mining regions about Fort Steele, British Columbia, still farther up the Kootenai, through the medium of river transportation.

About Fort Steele there is a good mining country, where a great deal of development work has been done. The miners expect when the mines are fairly opened to ship their ore down the river to Jennings, thence to be taken by the Great Northern Railroad to a smelting point.

The river is playing and must continue to play an important part in the development and settlement of a vast area lying on both sides of the boundary.

From Jennings to the boundary line the distance by river is about 65 miles. Fort Steele is about 70 miles farther up the river in British Columbia. There are said to be in the vicinity of Fort Steele about 1,000 inhabitants.

There are two small steamers running on this portion of the Kootenai, the *Annerly* and the *Libby*.

The *Annerly* is a stern-wheel steamer, 111 feet long and 21 feet extreme beam, with double engines, the cylinders of which are 8 inches by 72 inches.

The *Libby* is a smaller boat, being 70 feet long and 12 feet beam. It was built in the fall of 1894.

The *Annerly* has done most of the business on the river.

The river between Jennings and the international boundary line, 65 miles in length, is a fairly good river for purposes of navigation with some slight exceptions. At the higher stages of the river there is but one point where difficulty is met with, and this is at a canyon or gorge about 5 miles above Jennings. Here the rock walls of the river approach each other, causing an engorgement and considerable fall when the river is up. Large rocks are scattered about here and there in and below the gorge. These rocks are the principal sources of danger to boats running downstream, while the heavy fall and swift currents render the ascent of boats difficult, time consuming, and laborious.

It is probable that at the higher stages of the river lining will always be necessary, but it is believed that a small amount of work will render this process easier and safer and the downward passage of boats less dangerous than it is at present.

At extreme low water in the river there are several bars which cause trouble. These are where the low-water bed widens out, and the only remedy is to concentrate the river's flow into a narrower channel.

The words of the law, however, apparently confine the project to the removal of the rocks and obstructions from the canyon above Jennings.

To make a survey of this canyon and prepare plans and estimates for its improvement will cost, it is estimated, $500.

The accompanying letter from Mr. David G. Browne, collector of customs, shows the business on the river crossing the boundary line and coming within his official knowledge.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.
(Through Col. G. H. Mendell, Division Engineer.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., August 15, 1895.

Respectfully forwarded.

For reasons herein stated the Kootenai River is regarded as worthy of improvement to the extent recommended.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

LETTER OF THE COLLECTOR OF CUSTOMS, FORT BENTON, MONT.

OFFICE OF THE COLLECTOR OF CUSTOMS,
Port of Fort Benton, Mont., June 8, 1895.

DEAR SIR: I have the honor to acknowledge receipt of your favor of 4th instant, requesting information as to the values of exports and imports crossing the line and the duties levied and collected for as long a period as practicable on the Kootenai River from Jennings to British Columbian points.

I beg to inform you that the records of this office show the value of exports from May 1, 1893, to May 31, 1895, $18,225, and the value of imports for the same period $217.

Amount of duty collected during said period was $25.92.

In this connection I desire to state that the records of this office show that May, 1893, was the date of record of first steamboat on the upper Kootenai River.

The business for the present season promises to be quite heavy, and two steamers are now plying between Jennings, Mont., and Fort Steele, British Columbia.

Very respectfully,

DAVID G. BROWNE, *Collector.*

Capt. THOMAS W. SYMONS,
Corps of Engineers.

T T 32.

SURVEY AT PORT ORFORD, OREGON.

[Printed in House Ex. Doc. No. 313, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 13, 1895.

SIR: Section 12 of the river and harbor act of August 17, 1894, provides for a survey at Port Orford, Oreg.—

with a view to improving the same for shipping purposes and as a harbor of refuge, commencing at Graveyard Point, and by jetty, sea wall, or other proper construction

extending southerly or southeasterly into the ocean three hundred or more feet, if necessary, and suitable for vessels of middle draft; and, secondly, if necessary, by another jetty, sea wall, or other constructive work extending from the next high point or headland southwesterly four hundred or more feet, so as to accommodate vessels of maximum draft.

The survey thus provided for was assigned to the charge of Capt. Thomas W. Symons, Corps of Engineers, and I now have the honor to submit the accompanying copy of his report of January 30, 1895, with three drawings* of the results.

Captain Symons states that—

An inspection of the maps shows that Port Orford is wide open to the sea to the southward, the direction from which come the worst storms, and that the constructions, as located [at Graveyard Point and Nellys Point], are nearly head on to the sea and do not provide any inclosed anchorage area. This being the case, it is certain that they do not and can not be considered as providing in the remotest degree a "harbor of refuge." Therefore this view of the proposed improvements must be entirely cast aside, and they must be considered solely in relation to their use for "shipping purposes," as mentioned in the law.

He submits, therefore, estimates for the construction of wharves for commercial shipping purposes as follows, the greater cost providing a larger enrockment: Graveyard Point Wharf, $168,366 and $203,366; Nellys Point Wharf, $195,888 and $308,388.

This makes the total estimated cost of the two wharves, if built with the smaller enrockment, $364,254, and if built with the larger enrockment, $511,754.

Captain Symons further states that—

If the Nellys Point Wharf be built without the Graveyard Point Wharf it will cost, in addition to the above, $62,000 for railroad to quarry, locomotives, cars, quarry outfit, and wharf derrick. This would make the Nellys Point Wharf cost, with the small enrockment, $257,888, and with the large enrockment, $370,388.

Attention is invited to the accompanying indorsement of February 5, 1895, by Col. G. H. Mendell, Corps of Engineers, division engineer, Pacific Division, in which he states that—

It is not plain that the harbor would be improved to any great extent, if at all, by one or both of the piers extended from the promontories Graveyard and Nelly, neither of which is in topography well suited for commercial operations.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 30, 1895.

GENERAL: I have the honor to submit the following report with estimates of cost of improvement called for by your letter of August 30, 1894, for—

Port Orford, Oreg., with a view to improving the same for shipping purposes and as a harbor of refuge, commencing at Graveyard Point and by jetty, sea wall, or other proper construction extending southerly or southeasterly into the ocean three

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*Omitted. Printed in House Ex. Doc. No. 313, Fifty-third Congress, third session.

hundred or more feet, if necessary, and suitable for vessels of middle draft; and, secondly, if necessary, by another jetty, sea wall, or other constructive work extending from the next high point or headland southwesterly four hundred or more feet, so as to accommodate vessels of maximum draft.

Port Orford is an open roadstead and village on the coast of Oregon, 51½ miles north of the California and Oregon boundary line. A map of the coast in its vicinity is submitted, in order that a correct understanding of its general situation may be attained.

Upon a larger scale is a map of the village and roadstead of Port Orford, upon which are laid down the constructions mentioned in the law as the law is interpreted by me.

The plan of improvement as laid down in the law is the first and all that is known of its inception and preparation to this office.

The construction from Graveyard Point extends 300 feet in a southeasterly direction along the line of shallowest water.

The construction "from the next high point or headland southwesterly 400 or more feet," as shown upon the map, is believed to fulfill the law, and is in accord with the wishes and ideas of the people of Port Orford as gathered there. This point is designated as Nellys Point on the map.

In regard to this construction from Nellys Point, the plan of the work as given in the law is somewhat uncertain, as the word "southwesterly" may refer either to the "next high point" or to the direction of the construction. In the latter case it would be indeterminate which point was meant by the "next high point."

The constructions as laid down on the map are of the length mentioned in the law. They can be changed in direction, over wide angles, without modifying to any great extent their cost or usefulness.

An inspection of the maps shows that Port Orford is wide open to the sea to the southward, the direction from which come the worst storms, and that the constructions as located are nearly head on to the sea and do not provide any inclosed anchorage area. This being the case it is certain that they do not and can not be considered as providing in the remotest degree a "harbor of refuge." Therefore this view of the proposed improvements must be entirely cast aside, and they must be considered solely in relation to their use for "shipping purposes" as mentioned in the law.

These constructions for "shipping purposes" are therefore construed to be piers or wharves, and the estimate herewith is for their construction as wharves for commercial shipping purposes.

As these wharves extend out to sea, and are exposed to the swells and storms, it will be essential to their proper usage to provide head and breast mooring buoys, with heavy anchors, to facilitate vessels hauling away from the wharves in heavy weather, or other emergency.

As, however, they are not provided for in the plan given in the law, they are not estimated for herein.

It is also proper to add that the wharves can be used with regularity only during the summer season and when northerly weather prevails. They can not be used during the prevalence of heavy southerly winter weather. For the same reasons the wharves must be built during the summer months.

The only way that a harbor of refuge can be constructed at Port Orford is by building a breakwater approximately on the lines laid down by the engineers and Boards of Engineers, who have had the matter under consideration.

The breakwater locations as adopted by various engineers and Engineer Boards are shown on the map herewith.

Wharf construction.—Upon the drawings herewith are given profiles along the line of the Graveyard Point and Nellys Point wharves, as estimated for herein.

The constructions would be founded mainly on rock. Sand commences to show on the bottom 200 feet from Graveyard Point and 100 feet from Nellys Point, but as far as it could be ascertained it is not of great depth.

On account of the great exposure of these wharves it will be necessary to make them very strong, and the method suggested and covered by the estimate herein is to make them of a framework of iron, surmounted by a wooden floor, and with a base and hearting of rubble-stone. Both wharves are planned to be 42 feet wide and 15 feet above extreme high water, which is taken to be 11 feet above extreme low water. This height is rendered necessary by the exposure of the wharves to wave action. It may have to be increased.

The wharves are designed to be made of wrought-iron tubular piles, filled with concrete, and all tied together, as shown. The piles are 12 inches inside diameter and the metal three-fourths of an inch thick. They are arranged in bents, three piles to a bent, 19½ feet apart, the middle one vertical and the outside ones on an inclination of 20 on 1. The bents are spaced 15 feet apart, center to center.

In sand foundation the piles are designed to have cast-iron points and to be sunk to a firm foundation by a water jet. Where the bottom is rock the piles will be fastened thereto by heavy iron driftbolts.

The lengths of piles to be securely fastened together with sleeves and bolts. Twenty feet below the tops of the piles are horizontal strut connections to each pile, the longitudinal outside struts to be 9-inch lattice beams, all others to be 9-inch I-beams.

End connections are made with pins and bolts tc sleeves encircling and bolted to the piles.

The tops of the piles are to have iron caps fitting over the outside of the pile and fastened with bolts through the pile, having a projecting flange with bolt holes for the girder connections and sockets for the tie-rod connections.

Cross tie-rods 2 inches in diameter, with turn-buckles, are fastened to each pile above and below the strut connections. All turn-buckles are placed above low water.

In each bent a box girder of two I-beams 20 inches high, with top and bottom steel plates three-fourths of an inch thick, and 16 inches wide, are fastened with 4 three-fourths-inch bolts to the cap of each pile.

On top of these girders are fastened I-beams 12 inches high, 5 feet apart, made continuous by fish-plates and bolts. On top of this iron framework comes the wooden floor system, consisting of 12 by 12 inch beams and 4-inch planking.

Enrockment.—It is designed to secure the lower portions of the structures against the action of the seas as much as practicable by enrockments of rubble brought up to the greatest height possible compatible with the use for the wharves for shipping purposes.

Such rubble mounds would act to a slight degree as a submerged breakwater, and give a little protection in particular cases to a ship lying at the wharves.

If it is designed that both sides of the wharves shall be available for use for shipping purposes this rubble mound must be so limited that it will not interfere with ships lying at the wharves. In this case the protection given will be mainly to the wharves and very little to the ships.

If, however, only one side of the wharves be reserved for shipping purposes, the enrockment can be brought well up to high water on the other side, and a far greater degree of protection given to ships lying on the other sides of the wharves. The estimates include both sizes of enrockment.

The drawings which accompany this report indicate on the cross sections of the wharves the two enrockments.

Graveyard Point Wharf.—The location of the Graveyard Point Wharf is determined by a rocky ridge in the bottom, commencing 100 feet from the point and extending 100 feet in length. Along this the bottom is from 8 to 14 feet below low-water surface, while on each side of the ridge the water is 26 to 30 feet deep.

The wharf, if built to a length of 300 feet, will have its outer end in 36 feet of water, and there will be over 20 feet of water at low tide along 250 feet of its length. This fulfills the condition specified in the law of being "suitable for vessels of middle draft."

In estimating the cost of the work at Port Orford, it is necessary to remember that it is an extremely remote and isolated spot, and devoid of anything in the way of tools and appliances for carrying on such work. Lumber and stone and some labor can be procured in the vicinity, but all skilled labor and other supplies, tools, and appliances must be brought from some point, either from Portland or San Francisco, with which communication would be by water and expensive,. and more or less uncertain.

The nearest stone which is believed to be suitable for the work lies at a distance of about 7½ miles from Port Orford near Cape Blanco. It is a hard sandstone.

To reach it will require the construction of a railroad (narrow gauge) 8 miles in length.

There is a large deposit of fine granite which can be reached from Port Orford by a railroad about 11 miles long. The estimate herein is for the nearer sandstone.

To avoid injury to the iron piles and other ironwork of the wharf great care will have to be exercised in dumping the stone, and a large part of it will have to be lowered to place by a derrick. This will materially increase the cost of the enrockment over what it would be were the rock dumped freely.

Estimated cost of Gvaveyard Point Wharf.

8 miles narrow-gauge railroad, 30 pound rails	$40,000
2 locomotives, at $4,000	8,000
20 stone cars, at $300	6,000
Quarry outfit, engine, derrick, drills, blacksmith tools, quarters, living outfit, etc	5,000
Wharf derrick and engine for handling rock	3,000
230 tons iron piling, at $80	18,400
12 tons sleeves, strut and tie connections, etc., at $100	1,200
4 tons cast-iron caps and pile points, etc., at $60	240
180 tons beams and girders, at $80	14,400
62 tons wrought-iron tie-rods, etc., at $100	6,200
4 tons pins, bolts, etc., at $100	400
Iron construction, 492 tons, at $30	14,760
90,000 feet, B. M., lumber, at $14 in place	1,260
100 cubic yards concrete, at $10	1,000
10,400 cubic yards rock, at $2.50	26,000
Engineering and superintendence, 5 per cent	7,200
	153,060
Contingencies, 10 per cent	15,306
Total	168,366

If it be deemed wise to use the larger enrockment this will increase amount of stone required by 14,000 cubic yards and the cost by $35,000, making the total cost $203,366.

Nellys Point Wharf.—At the end of Nellys Point the water is 30 feet deep and it rapidly increases to 50 feet depth, which it maintains to the end of the proposed construction, 400 feet in length.

A wharf built on almost any line radiating from the end of Nellys Point will have nearly its entire length in water, which at low tide is 45 to 50 feet in depth. This certainly is sufficient "to accommodate vessels of maximum draft," as mentioned in the law. It is also sufficiently deep to make the construction and maintenance of the wharf difficult and expensive.

Nellys Point is very high and abrupt; at the water's edge the bluff in which it terminates is 100 feet high, 400 feet back it is 200 feet high, and at the distance of 1,000 feet it is 300 feet high above the water.

The only way that a wharf built out from this point can be reached for purposes of construction, except by constructing an elevator, is to work down to near the water level at Graveyard Point, and then to round the latter point and go around by the head of the cove between Graveyard and Nellys points.

Owing to the high bluffs and steep and rugged character of the shore line the construction will be expensive. The estimate herewith given for the Nellys Point Wharf presupposes that it is built after the Graveyard Point Wharf, and that the railroad, locomotives, cars, and plant for quarrying and handling the stone for the enrockment are on hand.

Estimated cost of Nellys Point Wharf.

Railroad connecting Graveyard and Nellys points	$10,000
440 tons iron piling, at $80	35,200
30 tons sleeves, strut, and tie connections, at $100	3,000
10 tons cast-iron caps, pile points, etc., at $60	600
250 tons beams and girders, at $80	20,000
75 tons wrought-iron tie-rods, etc., at $100	7,500
5 tons pins, bolts, etc., at $100	500
Iron construction, 810 tons, at $30	24,300
120,000 feet, B. M., lumber, at $14	1,680
180 cubic yards concrete, at $10	1,800
26,000 cubic yards rock, at $2.50	65,000
Engineering and superintendence, 5 per cent	8,500
	178,080
Contingencies, 10 per cent	17,808
Total	195,888

If it be deemed wise to use the larger enrockment, this will increase the amount of stone required by 45,000 cubic yards and the cost by $112,500, making the total cost $308,388.

This makes the total estimated cost of the two wharves, if built with the smaller enrockment, $364,254, and if built with the larger enrockment, $511,754.

If the Nellys Point Wharf be built without the Graveyard Point Wharf, it will cost, in addition to the above, $62,000 for railroad to quarry, locomotives, cars, quarry outfit, and wharf derrick.

This would make the Nellys Point Wharf cost, with the small enrockment, $257,888, and with the large enrockment, $370,388.

Port Orford is an open roadstead on the Oregon coast. Here the coast line takes a decided turn to the east, giving an excellent shelter

from northerly and northwesterly winds and weather. It is fully open to the south and southwest, the direction from which come the most severe storms.

It is located in Curry County, Oreg. This county had a population in 1890 of 1,500. It is increased, probably, to from 2,000 to 2,500. There are about 2,000 square miles in the county, the assessed valuation of which last year for purposes of taxation was $772,423. At the last election there were cast 527 votes.

The village of Port Orford is located on the bluff, overlooking the open water to the south, and has a population of perhaps 200 souls. The existing buildings of the village are shown on the map herewith.

There is a daily stage along the coast connecting Port Orford with the world. There is a regular steamer line that touches here, and other steamers come at irregular intervals.

Industries of Port Orford.—The following list shows the commercial industries of the place:

1 daily stage line, with post and express office.
2 hotels.
1 general merchandise store.
1 feed stable.
1 drug and commission store.
1 newspaper.
1 carpenter shop.
1 blacksmith and wagon shop.
1 boot and shoe shop.
1 church.
1 school.
1 saloon.
1 small sawmill with a capacity of 10,000 feet, B. M., per day.

In the vicinity of Port Orford there is a large body of fine timber land. This comprises over 100 square miles, covered with fir and cedar, embracing, it is said, the largest body of white, or Port Orford, cedar on the Pacific Coast.

Black-sand mining is carried on along the coast in the vicinity of Port Orford, and there are some quartz and placer mines on Sixes River to the north and east.

One of the principal industries of the country is cattle raising and dairy farming; there is said to be about 120 tons of butter annually produced in the vicinity of Port Orford.

The village of Denmark, 12 miles north of Port Orford, consists of a hotel, a blacksmith shop, and a cooper shop.

The village of Dairyville, 15 miles north, has a general merchandise store, a harness shop, two hotels, one stable, a sawmill, a cooper shop, a blacksmith shop, and three creameries.

To the south of Port Orford, the village of Mussel Creek consists of one hotel, and the village of Euchre Creek has a general merchandise store, a hotel and feed stable, a sawmill, and a wharf and tan-bark depot.

COMMERCIAL STATISTICS.

IMPORTS.

[General merchandise.]

	Tons.
1891	380
1892	260
1893	280
1894	517

EXPORTS (1894).

	Value.
Butter, 82 tons, at $440	$36,080
Wool, 67 tons, at $160	10,720
Merchandise, 70 tons, at $50	3,500
Bacon and lard, 6 tons, at $240	1,440
Eggs, 27 tons	680
Hides, 49 tons, at $40	1,960
Chittim bark, 3 tons, at $100	300
Machinery, 105 tons, at $10	1,050
Cedar lumber, 300 M, at $30	9,000
Total	64,730

During 1894 there were 45 arrivals and departures at Port Orford of steamers. The statistics at my disposal do not show that the port has been visited by any sailing vessels for a number of years.

Historical.—The construction of a sheltered harbor at Port Orford has been under discussion for many years.

In 1873, Maj. H. M. Robert, Corps of Engineers, made a project for constructing a harbor at Port Orford by building a breakwater 1,500 yards long, at an estimated cost of about $9,000,000. His location is shown on the accompanying tracing.

In 1877 the Board of Engineers for the Pacific Coast (Lieutenant-Colonels Alexander, Williamson, and Stewart and Major Mendell) made a second plan and location for a breakwater for a harbor at Port Orford. Their location is shown on the tracing. The estimated cost of their project was $10,507,343.

In 1878 Maj. J. M. Wilson, Corps of Engineers, made a third plan and estimate for a harbor at Port Orford. His location is shown on the tracing. His estimate for a breakwater 5,000 feet long was $9,405,000.

In 1880 a fourth plan and estimate was made by a Board of Engineers, consisting of Lieutenant-Colonels Stewart, Williamson, and Mendell and Major Gillespie. Their plan contemplated a breakwater 1,320 yards long in the location shown. This was estimated to cost $8,954,055.

In 1890 another Board of Engineers, consisting of Colonel Mendell, Major Handbury, and Captain Symons, was appointed to carry out the provision contained in the river and harbor bill of September 19, 1890, which required the Board to—

> reexamine the harbor at Port Orford, in the State of Oregon, with a view of minimizing the project and estimate of the proposed improvement for a harbor of refuge at that point to such proportions as will largely reduce the original estimate of such improvement heretofore made under the direction of the Secretary of War in pursuance of the previous action of Congress.

The Board adopted the location and length of the breakwater proposed by the Board of 1880, but reestimated the cost at $7,821,960. The Board further stated—

> that neither as regards location, direction, or length can the breakwater adopted by the Board of Engineers in 1880 be changed so as to reduce the cost and still have it perform the functions which it was designed to fulfill, namely, of making a harbor of refuge at Port Orford.
>
> The area protected by the designed breakwater, 224 to 316 acres outside of the 3-fathom curve, is the very least which the Board can recommend.

It is thus seen that this matter of constructing a harbor at Port Orford has been twice reported upon by individual officers of the Corps of Engineers and three times by Boards of Engineer Officers, the last time under specific instructions to minimize the project, etc.

The work of making the survey at Port Orford and collecting information bearing upon the plan of the work, etc., was intrusted to

Assistant Engineer Jos. G. Kelley, a portion of whose report is herewith.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., February 5, 1895.

Respectfully forwarded to the Chief of Engineers.

The argument of this report is that since the proposed construction can not create a harbor of refuge the law must mean that the structure shall improve the harbor for shipping purposes by affording a pier at which vessels may lie to receive or discharge cargo, which can be done only during the prevalence of northerly weather. The map shows a pier landing already existing, which is probably sufficient accommodation for the six or seven hundred tons of exports and the much smaller tonnage of imports shipped to and from this port in 1894.

It is not plain that the harbor would be improved to any great extent, if at all, by one or both of the piers extended from the promontories Graveyard and Nelly, neither of which is, in topography, well suited for commercial operations.

Perhaps the intention of the law is that shipping facilities are to be improved by giving protection in southerly weather to an anchorage to the existing wharf, and to a few other adjacent wharves likely to be built if the shipping period were made to cover the whole instead of half the year, as at present, or, otherwise stated, that the structure is to be a breakwater instead of a pier. The pier or breakwater proposed in the law to extend from either of the points, Nelly or Graveyard. assuredly would not make what it would be reasonable to designate as a harbor of refuge, for no sailor would think of seeking a refuge here in a storm; yet a breakwater of the length stated would shelter a small area under its lee, and it is possible to regard it as a part of a larger work to be built in future years, which may cover an area of anchorage of some acres, where vessels could lie with safety during southerly gales. A length of 300 feet extended from Graveyard Point would do something in giving cover to the existing wharf, while a length of 1,500 or 2,000 feet, suitably projected, could be made to shut off the waves as far round as Fort Point or farther, and give safe anchorage in good water of probably 50 and 100 acres respectively.

The port thus created could hardly be called a harbor of refuge, for the reason above given; but it would serve to accommodate the commerce of a half dozen wharves, more or less, throughout the year, with this qualification, that while vessels under the lee of the work would be safe in all weather it would be dangerous for vessels to attempt to enter during southerly gales.

It appears to me that if the latter interpretation be correct, the report ought to take in the future, and should determine the line of the work so that a future would be possible. Awaiting the construction that is to be put upon the language of the law, recommendation is reserved.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

EXTRACT FROM REPORT OF MR. JOS. G. KELLEY, ASSISTANT ENGINEER.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., December 19, 1894.

CAPTAIN: I have the honor to submit the following report on the survey of Port Orford, Oreg., complying with your letter of instructions dated October 15, 1894.

Soundings were taken on radiating lines from the outer part of three high points, known as Fort Point, Graveyard Point, and Nellys Point, for a distance of 1,100 feet, at spaces of 50 feet; also two lines in the harbor.

The soundings were carefully measured in pleasant weather, and reduced to an average lower low water of each twenty-four hours, agreeing with several high and low water heights given in the tide tables for this place.

The pivot points for the sounding lines were established by triangulation from a base on the center line of Fifth street of Port Orford, thus connecting with the survey of the town.

Several lines of soundings were made to conform as nearly as possible to the original lines, there being two lines from Graveyard Point, two lines from Nellys Point, one line in the harbor from Battle Rock, and one, an extension of a line, from Graveyard Point beyond the 1,100 feet.

These lines of comparison indicate a greater depth of water outward from Graveyard Point and Nellys Point, while close in shore at Fort Point and the different coves the water seems shallower.

The difference in depths of water in the harbor, and outward from Graveyard Point and Nellys Point, from the original survey vary from 1 to 6 feet.

Rocky bottom extends out from Fort Point 200 feet, from Graveyard Point 200 feet, and from Nellys Point 100 feet.

Outside of these distances all soundings show a sand bottom so compacted and of such a nature that it is impossible to sink sounding rods (churning or driving by hand) deeper than 18 inches.

This sand bottom is a splendid holding ground for anchors, it being stated by old residents that vessels never drag an anchor in this part, however rough the sea.

The shore line from Fort Point west to the straight line of the ocean is very rugged, the sharp points being steep and in places precipitous, extending to heights of about 50 feet at Fort Point, 200 feet at Graveyard Point, 250 feet at Nellys Point, and over 300 feet at the outer points called "The Heads."

The water line is so steep there is not much beach exposed at low water, extending from nothing at the points to 50 and 100 feet wide in the coves.

Flowing springs of fresh water are found in the coves above the high-water mark.

The shore line is so high, and in many places covered with timber, that it entirely shelters the harbor from the northwest winds, making the same a good roadstead for the summer months.

The prevailing storms in winter come from the southwest and due south, called here a "southeaster."

During several of these storms from both quarters while here I observed that a high sea and heavy swells, forming breakers, occurred during a southwester.

At the beginning of a southeaster a small sea runs in lines parallel to the shore, showing white caps, but little surf or combers.

The crest of the waves in a heavy sea at the outer point of the heads conform to the main line of the coast, and gradually approach the inner shore, which it in time becomes parallel to.

The crest of the waves form a line at Nellys Point south 16° 30′ east, at Graveyard Point south 20° east, and at Fort Point south 46° 40′ east.

North of Port Orford stretches a great plateau to the Coquille River, being from 50 to 100 feet in elevation above sea level, 4 to 5 miles wide, and covered mostly with burnt timber, with patches of green fir and cedar.

North of "The Heads" is Lake Orford, having an area of over 300 acres of fresh water 30 feet in depth.

About 4 miles north is the mouth of Elk River, flowing northwesterly to the ocean; 6½ miles is Cape Blanco light; 7½ miles is the mouth of Sixes River, flowing westerly to the ocean; 12½ miles is the mouth of Floras Creek, flowing southwesterly into Floras Lake and then into the ocean.

All of these streams head in the mountains from 18 to 25 miles distant from the ocean, and are the tributaries to over 100 sections of the finest timber lands of fir and cedar, embracing the largest body of Port Orford cedar on the Pacific Coast.

At the head waters of those streams are found large deposits of coal, chrome, and copper, while on Sixes River and its tributaries are good placer and quartz mines of gold.

The bottom lands are narrow in the hills, widening out through the plateau and along the coast.

Cattle raising and dairy farming is the principal pursuit, there being made at the present time about 200 pounds of butter annually for each cow, and 1,200 cows giving milk. This industry is in a prosperous, growing condition.

South of Port Orford to Rogue River the country is very hilly, having small streams flowing into the ocean, with patches of rich bottom land adjacent and open grazing lands on the hills.

The slopes of the hills are covered with patches of fir and live oak timber, the bark of which is used for tanning purposes. This live oak belt is about 15 miles long and 4 miles wide, two-thirds of the growth being live oak.

One hundred cords of bark has been cut from 1 acre of land; the average being about 25 cords.

The market price of bark this year is $9.50 per cord; freight, $4.50 per cord, and cost of cutting $1.25 per cord. Several vessel loads have been shipped from Euchre Creek this year.

Building materials of rock, sand, gravel, and lumber, in the immediate vicinity of Port Orford are very scattering.

The formation on the coast is a mixture of sandstone, serpentine, and conglomerate rocks in all conceivable shapes. This rock is a soft, blue graystone, suitable for some buildings, but too soft for structures exposed to the action of the sea.

The other rock along the coast is hard and soft; in places very shelly and brittle, falling to pieces on working and exposure.

A hard silica sandstone is found in a large body on the north slope of Cape Blanco, south of Sixes River, on land of Patrick Hughes, suitable for building construction, and the cheapest to get at for a medium-sized structure at Port Orford.

Good ledges are nearly uncovered and will require very little stripping to open a quarry on a large scale.

Inland, the rock formation is in large deposits of conglomerate porphyry, schist, and granite, with seams of quartz and coal.

The granite is the only rock suitable for building purposes, and extends from north of Elk River a little east of south for a distance of over 9 miles across the head waters of Brush Creek. Several creeks flow in deep canyons through this formation.

The true granite is over three-quarters of a mile wide, dips at an angle of 45° toward the south, extending to an elevation of over 300 feet above the bed of the creeks, and is in layers of different thickness.

The color is light gray, the composition being feldspar, quartz, hornblende, and some iron, but very little mica. The stone is very tough and splits well with the grain.

The best place to open a quarry is on the branches of Brush Creek, where fairly large areas of solid rock are exposed. It will require about 11 miles of railroad over easy grades to deliver this rock at Port Orford, which can be built at an expense of about $75,000 for a narrow-guage road. This granite belt is on unsurveyed Government land.

* * * * * * *

No sand or gravel deposits suitable for concrete can be found south of Port Orford.

Large deposits of sand and pea gravel are found along the coast from the mouth of Lake Orford north to Elk River.

The fine gravel is often covered with sand along the lake shores, while south of Elk River for a distance of one-half mile is a large layer of fine gravel about 250 feet wide and over 6 feet deep. Adjacent to this gravel is a large body of coarse sand on the shore of Elk River.

North of Port Orford about 5 miles, and extending nearly to Sixes River, is a belt of about 400 acres of fine saw and pile timber, which is about 1 mile long and two-thirds of a mile wide. This timber is along the line of a railroad going from Port Orford to the sandstone quarry south of Sixes River. The timber is on land of Patrick Hughes, J. S. Hughes, and estate of A. Crawford & Co.

For any medium-sized structure at Port Oxford material should be taken from this section, requiring about 7½ miles of railroad with switches, using about 3 miles of tramway, having line graded and ties laid for the rails.

The usage of the tramway and all rights of way will be granted.

Rock and timber can be had at a low figure. Sand and gravel can be had free of cost. To obtain large quantities of sand or gravel will require an additional switch and side track about 1 mile long.

Small amounts of sand and gravel can be hauled by team to the railroad and then by cars to Port Orford.

Very respectfully, your obedient servant,

JOS. G. KELLEY, *Assistant Engineer.*

T T 33.

SURVEY OF COOS RIVER, OREGON.

[Printed in House Ex. Doc. No. 237, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1895.

SIR: To comply with the requirements of the river and harbor act of August 17, 1894, a survey of Coos River, Oregon, was made by Capt. T. W. Symons, Corps of Engineers, and I have now the honor to submit the accompanying copy of his report, dated January 1, 1895, with map,* upon the subject.

The plan of improvement proposed by Captain Symons provides for removing all snags which are troublesome or liable to soon become so, and to clear the bowlders from a selected channel way through the shoals 50 feet in width. The total estimated cost of the work is $5,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: In compliance with instructions contained in your letter of September 1, 1894, I have the honor to report as follows upon the survey of Coos River, Oregon:

Coos River is the principal tributary of Coos Bay, and empties into the bay at its head, opposite the town of Marshfield. At 5½ miles from its mouth it divides into two branches, known as the North and South forks. The river has a small drainage area on the western slope of the Coast Range of mountains, and flows through a narrow but fertile valley. The tidal influence extends for about 8½ miles up each fork.

The river is the principal and almost only highway of commerce in the country in its vicinity and has great value to the people living along its banks. The map which is herewith shows the general plan of the river. Upon the forks the head of navigation is shown. From the head of navigation on each fork down to the bay a survey of the river was made by Mr. J. S. Polhemus and Mr. Morton L. Tower, the results of which were platted on a large sheet, which is on file in this office, and from which the map sent has been compiled.

There is an average tide of about 5 feet in the portion of the river between the bay and head of navigation, which gives ample water for purposes of navigation.

The obstructions to navigation were found to consist of snags and bowlders. In making the survey every snag observed was located and it was found that there were 800 of them. This number of snags necessarily varies, some being washed away and others being brought in.

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*Omitted. Printed in House Ex. Doc. No. 237, Fifty-third Congress, third session.

There were found to be five bowlder shoals, the bowlders having been brought down by slides in the steep tributary creek ravines.

The plan of improvement proposed consists in removing all snags which are troublesome or liable to soon become so and to clear the bowlders from a selected channel way through the shoals 50 feet in width. For doing this work it is proposed to borrow from the plant used in the improvement of the entrance to Coos Bay such as can be used to advantage in the work of snagging or bowlder removal at such times as it can be spared. It may also be found advantageous to use the dredge to be built for improving the upper harbor of Coos Bay. In making the estimate of cost, therefore, no provision is made for the purchase of new plant. It simply covers the adapting of plant on hand or which will be on hand to the end in view and the actual expense of doing the work.

Estimate.

Fitting up the snagging outfit by borrowing scows, hoisting engine, diving apparatus, and some tools from the work of improving entrance to Coos Bay and Harbor, Oregon	$600
Removal and disposal of a total of 800 snags from both forks and main river, at $3 each	2,400
Clearing of a passageway 50 feet wide and 3 feet deep at mean lower low tide through 5 bowlder shoals, at $100 each	500
Engineering, office expenses, contingencies, return and repair of plant used, etc.	1,500
Total	5,000

The report of Mr. J. S. Polhemus, assistant engineer, is herewith.

Very respectfully, your obedient servant,

THOMAS W. SYMONS.
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded. Recommended.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. J. S. POLHEMUS, ASSISTANT ENGINEER.

EMPIRE CITY, OREG., *October 27, 1894.*

CAPTAIN: In accordance with the instructions contained in your letter of the 10th of September I have the honor to submit the following report on the survey of Coos River, Oregon, with a view to its improvement from the head of navigation on both branches to its mouth.

The field work was executed during the first two weeks of this October by Morton L. Tower after a careful examination by myself to decide upon the necessary ground to cover in order to form an accurate estimate of the cost of improvement.

A stadia survey was made and soundings taken on the following shoals and obstructed stretches of the river, viz:

The shoals and obstructed channel at and for a distance below the head of navigation on both forks of the river, Caroline Bar, on the North Fork, and the shoals at Yoakams and Carpenters, on the South Fork. This work has been platted on a

scale of 200 feet to the inch, which map* accompanies this report, as does also a township map including the whole navigable part of the river on a smaller scale.

The soundings were reduced to mean lower low water from the tidal readings taken by the Government inspector, Major Tower, at the quarry during the survey.

It was not deemed necessary to survey the balance of the river channel, although it was carefully observed and the snags counted where visible.

The condition of the river's mouth can be seen by reference to the Coast Survey map of 1892 (Coos Bay, No. 5984). The bed of the river to the head of navigation is a mixture of sand and mud.

The same physical and commercial conditions of the river prevail as mentioned in my report to you of an examination dated October 8, 1892. One more small creamery has been started on the South Fork; otherwise I can not do better than to reiterate my original description, as follows:

General description.—The North and South forks, which unite to form the main Coos River about 6 miles from Marshfield, are fed by a number of insignificant mountain streams which take their rise in the hills along the eastern border of Coos County.

Coos River empties into Coos Bay nearly opposite the town of Marshfield. The tidal influence extends up both forks for a distance of about 8½ miles from the junction to the head of navigation for small steamboats. Beyond the forks are not navigable for small boats for any distance.

The range of tide is only slightly diminished in going up the river and is about 5 feet.

At the mouth of Coos River there is a mud bar formed by the deposit of silt brought down the river during the freshets, on which the ruling depth is about 4 feet at mean low water.

The river from its mouth to the forks, about 5½ miles, is moderately straight and from 400 to 700 feet in width and navigable at any stage of the tide for boats drawing 6 to 7 feet. This stretch has but few snags which need removal.

The South Fork is navigable for light-draft steamers at high water to the head of tide, at Mr. McKnight's place, about 9 miles. Along the upper 2 miles the ruling depth at low tide is about 1 foot and snags and rocks are more frequent. This fork is from 100 to 200 feet wide,

The North Fork is navigable the same way about 8½ miles to Mr. Laird's place, where a broad-gauge railroad 3 miles long brings in logs for the California Lumber Company. It is about the same width as the South Fork.

The water in the river is generally salt for several miles up the forks. Freshets sometimes occur, when the river rises 15 or 20 feet and overflows its banks.

The river flows in a valley between hills from 300 to 800 feet high which in places slope to the water in rocky bluffs. On either side is generally a strip of fertile bottom, varying in width from a couple of hundred feet to half a mile, and is nearly all in a good state of cultivation, raising hay, oats, potatoes, and fruit. Several hundred cows are supported along the stream.

Myrtle grows on the bottoms and fir on the hills, especially as one ascends the tributaries. The bed of the stream is for the most part of sandy mud.

There are no towns on the river, but the country is well settled and the farmers are prosperous.

A creamery with a $7,000 plant was started on the river this year (1892) and consumes about 9,000 pounds of milk per day.

Three small steamers ply on the river from Marshfield, the *Coos River*, drawing about 3½ feet; the *Milton*, about 4 feet; and the launch *Butcher Boy*. They carry passengers, hay, milk, beef, cheese, produce, apples, etc., and tow logs and scows.

Some years from 5,000,000 to 15,000,000 feet of logs come out of Coos River.

The Government owns a stone quarry on each fork, from which the supply of stone for the jetty at the bar is obtained.

Scheme of improvement.—The head of navigation of any kind is at McKnight's place on the South Fork, and at the junction of the East and West forks on the North Fork.

The obstructions to navigation consist of sunken snags, principally of fir, myrtle, and maple of various sizes; and five shoals of sandstone bowlders which have been carried down from the hillside in slides in the small and steep creek ravines, as shown on the map.

With the removal of the snags and portions of the five bowlder shoals, three of which are on the South Fork and two on the North Fork, a good navigable channel would be secured, with a ruling depth of not less than 1 foot at mean lower low tide to the head of navigation on both branches, and not less than 3 feet at the same stage of tide to within 1¾ miles of the head of navigation on the South Fork, and to within half a mile of the head of navigation on the North Fork.

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* Omitted.

As the average range of tide is nearly 5 feet this gives ample depth for all requirements of commerce and is all the people ask for, especially as very suitable boats can be built to draw not over 2½ to 3 feet, loaded, and none of those now plying the waters exceed a draft of 4 feet.

In making the estimate I have assumed that most of the necessary plant for fitting up a snag puller, for the removal of the snags and bowlders, can be borrowed for six or eight weeks from the work of the improvement of the entrance to Coos Bay, or from the dredging work at Marshfield, with advantage to the Government and no detriment to those works. Eight weeks in the summer should afford ample time to accomplish the work.

Either the proposed dredge for the shoal at Marshfield could be used, or one of our brush scows could be fitted up with a hoisting engine and shear legs.

We possess a diving apparatus and steam pump and other tools that could be used.

Very respectfully, your obedient servant,

J. S. POLHEMUS, *Assistant Engineer.*

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

T T 34.

SURVEY OF ALSEA RIVER, OREGON.

[Printed in House Ex. Doc. No. 235, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1895.

SIR: I have the honor to submit the accompanying copy of report dated January 1, 1895, with map,* by Capt. T. W. Symons, Corps of Engineers, of the results of a survey of Alsea River, Oregon, made to comply with the requirements of the river and harbor act of August 17, 1894.

The project submitted by Captain Symons proposes the improvement of the downstream navigation of the river at the higher stages from the forks to the head of tide by the removal of rocks and other obstructions, at an estimated cost of $3,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report on the survey of the Alsea River, Oregon, and to submit plans for its improvement, with estimates of cost.

In making this survey and preparing plans and estimates I have been guided by the preliminary report of October 10, 1892, approved by Col. G. H. Mendell, division engineer, under date of October 17, 1892, as regards the character of the improvement to be provided.

For a general description of the Alsea River and valley attention is invited to the report of this preliminary examination published in House Ex. Doc. No. 53, Fifty-second Congress, second session.

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* Omitted. Printed in House Ex. Doc. No. 235, Fifty-third Congress, third session.

Accompanying this report is a map of the Alsea River from the forks to the sea.

The work proposed to be done and covered by the estimate herewith has in view the improvement of the downstream navigation of the river at the higher stages from the forks to the head of tide.

The survey of the river was made by Mr. Holland W. Baker, assistant engineer, whose report is herewith.

A line of levels was run from the forks to the head of tide. The total distance by river between these points is 31 miles, and the total fall is 248.57 feet. This gives an average fall to the river of 8 feet per mile.

The obstructions to the proposed navigation met with are described in Mr. Baker's report, and consists of isolated rocks, about 75 in number, a few pieces of bed rock, and three small wooded islands, which collect drift.

The total amount of work required in the improvement of the river is small, but its isolation will render it somewhat expensive to accomplish. It is probable that when the actual work of improvement is undertaken, if so it be, that there will be changes in the location of the rocks, and others may have been brought in.

The total estimated cost of doing the work required is $3,000

Mr. Baker's report gives in detail the work which it is proposed to do.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded. Recommended.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. HOLLAND W. BAKER, ASSISTANT ENGINEER.

PORTLAND, OREG., *October 10, 1894.*

CAPTAIN: In accordance with your instructions, I left Portland on the 18th of September, 1894, for the Alsea River, to run a line of levels from the upper forks of same to the head of tide, and examine the river en route for the purpose of locating the more serious obstacles to the open-boat navigation in vogue thereon, and taking notes sufficient to base an estimate for the removal of such obstructions as were found to be necessary.

I took a rodman and camp outfit with me, proceeded to Corvallis by rail, and from thence across the summit of the Coast Range into the upper Alsea Valley, by the only available means, viz, private conveyance.

Here a boatman conversant with the river was secured, an open boat 14½ feet by 4 feet constructed, and work proceeded with down the river.

Commencing at the forks of the upper Alsea River, a bench mark was established upon an ash tree within the forks, and about 50 feet above them, and marked by a tenpenny nail driven into the point of a triangular pyramid cut in the body of the tree, near the root.

The line of levels was continued down to Hoover Rapids, or "The Falls," as it is more commonly called, to which point the tides from the bay back up, and here they ended upon a bench mark, marked as above and located upon an alder tree, 20 inches in diameter, situated upon the right bank, abreast of the foot of the rapid, 50 feet from same, and closely adjacent to the wagon road and between it and the river.

The difference in elevation between these two bench marks, as thus shown, is 235.20 feet, and the difference in elevation of the water surface at the forks and at the head of Hoover Rapids at low stage of river is 248.57 feet.

No attempt was made at measuring distances along the river, the data regarding which is that afforded by the Land Office maps, obtained from the surveyor-general of the State. All of the other figures given, aside from those pertaining to levels, are estimates from inspection.

Without rehearsing in any way the arguments and statements made in previous reports, or traversing the grounds therein gone over, it may be added that the Alsea River, between its upper forks and the head of Hoover Rapids, meanders a length of 31 miles, with a ruling low-water width of 50 feet down to its confluence with Five Rivers, a distance of 21¾ miles, and of 80 feet from thence down.

It is essentially a mountain torrent. Its average low-water slope is 8 feet per mile, and this is quite largely massed in numerous riffles and rapids, with intervening pools of still water. Its bed is very rocky, being largely composed of a sand rock in place throughout the lower two-thirds of the portion leveled, with numerous rocks, both loose and in place, encumbering its course throughout.

In numerous places this bed rock is grooved and channeled quite uniformly in courses parallel with the current to depths of 3 feet and widths of 3 to 5 feet, with the intervening rock ridges averaging 18 inches in width.

The precipitous nature of its watershed renders the river very flashy in its rises and falls, either one quite commonly varying 6 or more feet in twenty-four hours.

With water at the high stage, a boat can be run by two men from the forks to tidewater in six hours.

The usual sizes of boats vary from 28 feet length by 6 feet beam to 36 feet length by 8 feet beam, and will carry loads of from 10,000 to 16,000 pounds, at a total cost of from $16 to $20 for boat (which is abandoned after one trip) and help, or a cost for transportation of 12½ to 16 cents per 100 pounds.

The only alternative for getting out the products of the Upper Alsea Valley is the tedious and costly haul over the rough mountain road to Corvallis, the cost varying with the condition of the road from 50 cents to $1.25 per 100, with an absolute impossibility to get products out by that route for the major part of the late fall and winter seasons.

At low water it is impracticable to get even an empty boat down the river.

At a good high stage one accustomed to run the river can usually succeed in getting a loaded boat through safely notwithstanding the present serious impediments to navigation, but, as above instanced, the high stage of river is a very ephemeral thing, and the fall which will occur in a very few hours adds greatly to the dangers of the transit, although the points of peculiar danger are not very numerous, being mainly concentrated at the various rapids, as will be more particularly designated hereafter, and a few brushy islands, which collect drift badly at times of high water.

With these places improved the course could be run with comparative safety at any medium stage of the river. This alone would give immediate and substantial relief. To do more than this would be useless, unless a systematic course of clearing the channel throughout its entire length were attempted, which would involve a very much more considerable outlay than the merits of the question would justify. In fact, the parties most in interest would be well satisfied if these especially bad places were improved.

They are as follows:

One-half mile below the forks of the river a chain of loose rocks extends across the channel. About 12 of these should be removed. All of them can be gotten out of the way with crowbars, etc.

At 1¾ miles below the forks, or three-eights of a mile below the grist and saw mill, are a dozen loose rocks in the middle of the channel that should be removed. They stand about 2 feet out of water at low stage, and can be removed as above.

Tobacco Rapids-—These rapids are located 4 miles below the forks, and are the first very serious obstacles encountered. A sharp turn in the river above, with a rocky island directly in the rapids, narrowing the boat channel to 20 feet in width with falls therein of 20 inches, and a large basalt rock at the falls and directly in the boat channel at the gorge make this passage a bad one.

Just above this is a fall of 12 inches at low water, with two rocks in place in the line of the falls and directly in the boat channel.

These three rocks should be removed, and will require blasting. Their total volume does not exceed 8 cubic yards.

Wooded Island No. 1.—At Garrison's ranch, 7 miles below the forks, an island 150 feet by 50 feet in dimensions divides the river, making both channels narrow and catching drift badly, as it is well covered with heavy brush and saplings This should be cleared off,

Ten miles below the forks, and five-eights of a mile above "Devils Jump Off," are 5 loose rocks of about one-half cubic yard each in the channel They stand 2

feet out of low water, and bother some at medium boating stages. They should be removed.

"Devils Jump Off."—This is located 10⅝ miles below the forks and 2½ miles below the mouth of Salmon Creek. The rapids are about 200 feet in length, with the low-water boat channel about 25 feet wide. The low-water fall in the length of the rapids is 6.89 feet. The rock is all a sandstone. The right side of the channel is a flat rock ledge, which, toward the lower end, extends completely across the river, with a channel 14 feet wide worn through it to a considerable depth.

There are about 30 loose rocks scattered along the upper portion of the rapids, mostly of about one-third of a cubic yard contents, with 3 of the larger ones of about 2 cubic yards contents.

At the lower end of the rapids, and directly in mid-channel, are 2 sandstone rocks, the upper one measuring 9 cubic yards, and the lower one half that amount. They are well surrounded by deep water and need only to be well shattered.

Just below these are 2 snags 18 inches in diameter, which have remained there two and four years, respectively, and are a menace as catchers of drift.

The rock in place in this section is smooth-surfaced, and although at medium stage of the river, and in fact at almost any stage of the river, boats will ground upon them more or less, the strong current forces them off without any severe shock, and they do not constitute any great menace to boating; but the loose rocks at the upper and lower ends of the reach and the snags are more serious and need removing. Nearly all of these rocks can be removed readily out of the channel and onto the bank. A few only will require blasting, and with this small amount of work done this place will cease to be formidable.

Shovel Handle.—Three-eighths of a mile below "Devils Jump Off" is "Shovel Handle," and in the bend above this are three troublesome rocks, the worst being the smallest, lying directly in the channel between the others, and is further designated by a small willow tree or large twig growing in a crevice in same. All should be removed.

Wooded Island No. 2.—Eleven and one-half miles below the forks is a small wooded island, 150 feet by 40 feet in dimensions, similar to the one previously described and requiring the same treatment for the same reasons.

Digger Creek Rapids.—Just above the mouth of Digger Creek, which is 13 miles below the forks, are the Digger Creek Rapids, with an approximate length of 300 feet, width of 50 feet, and fall of surface at low water of 5.16 feet.

This forms a very bad reach of river. To effectually help matters will require (referring to accompanying sketch) the removal of the loose rocks along the left bank, a half dozen of those at the lower end upon the right bank, and about 20 feet of the outer end of the reef marked A, which stands about 3 feet out of low water.

The strong current in the approach to the rapids and the sharp turn required around reef B will almost inevitably throw a boat upon reef C, but with the removal of the obstructions mentioned, reefs B and C will cease to be a menace and will doubtless prove beneficial rather than otherwise, as they will tend to confine the flow to the newly straightened channel along the left bank.

All of the material is a soft sandstone and the loose rocks are of about one cubic yard volume each.

Round Mountain Rapids.—These rapids are located 14 miles below the forks and 1 mile above the mouth of Fall Creek. The low-water surface has a fall of 10.47 feet. At the head the section is wide, with a discontinuous rock ledge extending nearly across the channel, standing at low water 3 feet above the surface on the lower side of ledge. Several rock reefs are found throughout the course of the rapids, with the intervening spaces pretty well covered with loose rocks. Most of the latter, however, are found along the middle and lower portions of the reach, where the river section narrows and a comparatively small rise covers them well. The rock in place is smooth-surfaced, and boats slide over them without serious difficulty. Formidable as it looks at low water, it is not as dangerous in the boating season as some other sections, and with the removal of the few rocks indicated upon the sketch will be rendered comparatively safe.

Wooded Island No. 3.—At the first sharp bend in the river, one-fourth of a mile below Fall Creek, an island 200 feet by 30 feet, similar to those previously described, requires the same treatment.

An especially bad approach to this island renders it peculiarly obnoxious when drift lodges upon it.

Stone Mountain Rapids.—These rapids are located 20½ miles below the forks and 1½ miles above the mouth of Five Rivers. They are 200 feet long and have a low-water slope of 6.5 feet. Half a dozen of the worst rocks should be removed. All of them are loose and average about one-half of a cubic yard each.

The Slide.—This is located one-third of a mile below Stone Mountain Rapids. A medium-sized, sharp-pointed, pyramidal rock, directly in mid-channel at the foot of the rapids, is the only serious obstacle to be removed.

Hellyan Rapids.—These are located 5¾ miles below the mouth of Five Rivers. One loose rock and one apparently solid one of about two-thirds cubic-yard volumes are the only serious obstacles.

McEwing Rapids.—These rapids are located 1½ miles below Hellyan Rapids. Two loose rocks lying upon the left bank at low water, almost in line with three alders, 10 inches in diameter, are the main obstructions.

The foregoing constitute the principal impediments to navigation in the Alsea River at a medium stage of same, from the forks down to the head of tide. Below this point and down to Waldport, near the mouth of the bay, no obstructions exist to the passage of the boats coming down the river.

A narrow gravel bar one-half mile below the Tidewater post-office and a wide sand bar about one-half mile across the crest located near the head of Alsea Bay, upon either of which only 12 inches of water is to be found at extreme low tide, obstruct the navigation of this portion of the river for steamboats or any craft requiring any great depth of water.

The present necessity for any such craft in these waters is not very apparent, and should an emergency arise necessitating their occasional appearances, advantage can be taken of high tides for such emergency.

The cost of any adequate and permanent improvement of these places would be considerable, and for the present, with its very limited demand, their improvement would scarcely seem advisable.

The improvement of the river proper, as above outlined, can be done at an estimated cost of $3,000, and with this done a very substantial and permanent relief will be afforded to the upper Alsea country.

I am, Captain, very respectfully, your obedient servant,

HOLLAND W. BAKER,
Assistant Engineer.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

T T 35.

SURVEY OF NESTUCCA RIVER, OREGON, FROM TOWN OF WOODS TO THE OCEAN.

[Printed in House Ex. Doc. No. 224, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 18, 1895.

SIR: I have the honor to submit the accompanying copy of report dated January 1, 1895, by Capt. T. W. Symons, Corps of Engineers, of the results of a survey of Nestucca River, Oregon, from town of Woods to the ocean, made to comply with the requirements of the river and harbor act of August 17, 1894.

Captain Symons submits a project for the removal of a rocky reef which forms a dangerous obstruction at the entrance to Nestucca Bay, at an estimated cost of $6,000, and states that:

> No estimate is made for the improvement of the river between the cannery and the town of Woods, it furnishing now fairly good facilities for navigation with small boats, and the situation being such as to render it extremely difficult, if not impossible, to make any betterment of a marked and permanent character.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report on the survey of "Nestucca River, Oregon, from town of Woods to the ocean," required from me by your letter of September 1, 1894.

House Ex. Doc. No. 97, Fifty-second Congress, second session, contains a description of Nestucca Bay. This document is a report on the preliminary examination of the bay.

The work found necessary at Nestucca Bay in the interests of commerce and navigation is the removal of a rocky reef which forms a dangerous obstruction at the entrance to the bay. This reef is 100 feet in length and from 24 to 30 feet in width, and it rises to just about extreme low water. The depth of water around the reef varies from 12 feet along the seaboard side to 9 feet at the channel end and 6 feet on the upper or bay side.

It consists of a soft sandstone. The reef lies in the harbor throat in a position which makes it especially dangerous. Its exposed condition will also make it somewhat expensive to remove. The removal of this reef would render it much safer for the coasting vessels, which pay an occasional visit to the river, to enter and proceed to the cannery and leave the supplies which they have for the country and receive the products to be shipped out.

No estimate is made for the improvement of the river between the cannery and the town of Woods, it furnishing now fairly good facilities for navigation with small boats, and the situation being such as to render it extremely difficult, if not impossible, to make any betterment of a marked and permanent character.

The enormous masses of loose, drifting sand and the small amount of tidal and river water flowing make a combination which is practically certain to render abortive any attempt to make and maintain a channel throughout the length of the river sufficient for coasting vessels at ordinary stages of the tide.

It is proposed to remove the rock to a depth of 9 feet at low water, and the estimate is made accordingly.

Estimate.

Removal 1,000 cubic yards rock, at $5	$5,000
Engineering, superintendence, office expenses, and contingencies	1,000
Total	6,000

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded. Recommended.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

T T 36.

SURVEY OF NOOKSACK RIVER, WASHINGTON.

[Printed in House Ex. Doc. No. 276, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 26, 1895.

SIR: The river and harbor act of August 17, 1894, makes provision for survey of Nooksack River, Washington, and the duty of making the survey required was assigned to the charge of Capt. Thos. W. Symons, Corps of Engineers. I have now the honor to submit the accompanying copy of report of January 14, 1895, with two maps,* by Captain Symons, upon the survey provided for, in which he states that if the mouth could be opened and kept open, the expense of keeping the river itself free from snags could properly be borne by the general appropriation for snagging in Puget Sound and tributary waters, and no estimate is therefore made for this work.

Captain Symons states that the great trouble with the navigation of the river is at its mouth, and he submits two alternate plans for improvement at that point. He estimates that the improvement under either plan will cost $25,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 14, 1895.

GENERAL: I have the honor to submit the following report of a survey of the Nooksack River, Washington, required from me by your letter of September 1, 1894.

The Nooksack River rises in the Cascade Mountains near Mount Baker, and flows generally west, emptying into Bellingham Bay, one of the numerous portions of the great body of water known as Puget Sound.

It is a mountain stream, subject to heavy freshets, and rises and subsides with great rapidity. The river drains a country covered with brush and timber, and the freshets bring down many snags, which, lodging in different places, interfere with navigation.

In its lower portion the river flows through a low-lying and very fertile valley. Through this valley it flows in a narrow and crooked channel, which is ever changing by the erosion of one bank and building up of the other. The tide ebbs and flows in the river, and there is generally water enough for small river steamboat navigation as far up as Lynden, 21 miles from the mouth, which must be considered the head of navigation, although at high water boats could go a little farther up.

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* Omitted. Printed in House Ex. Doc. No. 276, Fifty-third Congress, third session.

In the river proper the chief difficulty met with in navigating it arises from snags. These could be cleared out from time to time by the Government snag boat if it could get into the river.

No estimate is made for this work, as it is of such a nature that it must be done again and again, and can be most properly provided for in the general appropriation for operating the snag boat *Skagit*. On account of the condition at its mouth, the snag boat is seldom able, however, to get into the river.

The great trouble with the navigation of the river is at its mouth. Here, where the river debouches into the tide flats, booms have been built for catching saw logs, and these constructions, together with the logs and drift of all kinds caught thereby, have very effectually closed the river to ordinary navigation. It is now almost an impossibility for boats to get into the river.

Added to these obstructions is the great area of tide flats about the river's mouth. These have an average elevation of 4 to 5 feet above low water, and act as a dam to the free outflow of the river. Boats could, however, cross these flats at high tide and get into the river were it not for the boom and jam.

The obstruction of the entrance to the river by the Bellingham Bay Boom Company has been the subject of complaint for several years, and now a suit has been brought against the company to compel it to alter its booms so as to remove their obstructive character.

The company has pleaded a demurrer, setting forth that it has acquired rights in the Nooksack River by the erection of valuable and costly improvements prior to any legislation on the subject of obstructions to navigable rivers by Congress. It insists that its rights are vested and valuable property rights, and can not be taken or destroyed without full compensation by due process of law.

The case has not yet been decided.

Besides the direct obstruction to navigation by blockading the river with booms, logs, drift, etc., great damage is done by its preventing the free outflow of the river during freshets; hereby the valley lands are overflowed, and great annoyance and loss caused.

The plan to be adopted for the improvement of the river will depend on the validity of the claim of the boom company. The map herewith shows the situation at the mouth of the river.

Two alternate plans for its improvement are suggested.

Plan A.—If the courts decide that the boom company has no rights which are paramount to the rights of the United States to make any changes or improvements which may be deemed in the interests of navigation, then Plan A should be adopted as being best suited to afford a good entrance to the river.

This plan contemplates the opening of a channel way through the drift, logs, and boom next to the main shore, and between the shore and Delta Island, and thence turning eastwardly out into the wide water, and the closing of the channel lying to the north of Delta Island, known as Steamboat Channel.

If for legal reasons it is deemed best not to adopt this plan, then Plan B should be adopted. This contemplates the closure of the channel between the main shore and Delta Island, and the training of the main channel to the north and east of Delta Island by way of Steamboat Channel.

The cost of either of these plans would be about the same, and either would give a good entrance to the river, accessible at any time when a boat could cross the tide flats. It is believed that by thus confining

the river to a single channel, and directing it in a single channel across the tide flats, it would scour out and maintain a reasonably good channel across the flats.

If the mouth could be opened and kept open, the expense of keeping the river itself free from snags could properly be borne by the general appropriation for snagging in Puget Sound and tributary waters. Therefore no estimate is made for this work here.

The estimated cost of the work required for either plan, at the mouth of the river, is $25,000, as follows:

Plan A.

Removing log jam, drift, and boom piles	$5,000
1,200 feet training dike of piles, brush, and stone at $8	9,600
500 feet pile and lumber revetment, at $3	1,500
900 feet training dike across head of Steamboat Channel, at $7	6,300
Engineering, superintendence, and contingencies	2,600
Total	25,000

Plan B.

650 feet training dike at old mouth, at $7	$4,550
Removing piling and jam, head Steamboat Channel	500
500 feet dike at head and foot of Brush Island, at $7	3,500
2,000 feet dike, east side Steamboat Channel, at $7	14,000
Engineering, contingencies, and superintendence	2,450
Total	25,000

Two tracings are submitted; one of the entire navigable portion of the river, and, on a larger scale, one of the mouth, showing the alternate plans as proposed.

The report of Mr. David B. Ogden, who made the survey, is herewith.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 19, 1895.

Respectfully forwarded.

I agree with Captain Symons that there should be but one mouth to the river, and that the best position for it is between the shore and Delta Island; the other channel to be closed.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. DAVID B. OGDEN, ASSISTANT ENGINEER.

PORTLAND, OREG., *December 7, 1894.*

CAPTAIN: I have the honor to submit the following report on the survey of the Nooksack River, State of Washington:

In accordance with your instructions, this survey was to include an especially detailed examination at the mouth of the river, accurately locating the present boom construction, log jam, and various channels; also an examination of the old

channel to Lummi Bay, and a general survey of the river proper from the crossing to the mouth.

The survey was begun at Everson, 29 miles from the mouth, October 3, and the work at mouth completed October 23.

Survey of river proper.—This survey was confined principally to the adding of topographical and hydrographical details to sectional field plots of 500 feet scale, compiled from Land Office maps and data. Where marked differences were found between the plots and the present course of the river making sketching impracticable, the river was relocated with reference to existing section lines and corners by stadia measurements and compass bearings. I transmit herewith a map showing the present condition and location of the river, with a single line of soundings taken in channel, expressed in feet. By reference to the maps it will be noticed that there are numerous shoals between Lynden and Everson, making this stretch of river practically unnavigable excepting during times of high water.

I am told that the only steamboat that ever attempted to run above Lynden reached "Schoolhouse Landing," 5 miles farther upstream, and could get no farther, and on her return trip she had seven holes staved in her hull in striking bad rocks before reaching Lynden. These rocks I was unable to locate, as the river was at a high stage during the survey in this section. With exception of two short shoals, the river below Lynden is in a fairly navigable condition, and were boats but able to enter at the mouth, no particular trouble would be experienced in reaching Lynden at any season of the year. There are numerous snags and leaning trees in this stretch of river, the removal of which would facilitate navigation. The nature of the soil forming the banks of the river is such that it yields very readily to the action of the current, hence the position of the river is continually shifting and changing, and thus an enormous amount of sediment is carried down river to be deposited in the stream below or on the flats at its mouth. This state of affairs can not well be prevented except by a complete system of shore protection along the entire river, for should the cutting away be prevented at one point, it would at once begin elsewhere.

Examination of "Old Channel."—This channel never having been meandered, I could secure no data from which to make field maps, so it was necessary to locate the general course by sketches and occasional reference by stadia to known section lines. The accompanying map represents approximately the location of this channel. The distance from its head to the mouth at Lummi Bay is 5½ miles.

A close jam of logs and drift now closes the head of this channel so that little or no water flows into it, but I judge from the present heavy cutting of the bank just above the head of this channel that it will not be long before the river again makes its way into the channel. I would suggest, if it is thought best to prevent this dividing of the waters, that the bank above the head be protected by brush and stone riprap for several hundred feet. At ordinary high tide salt water flows throughout the entire length of the channel, giving a depth of from 2 to 6 feet.

I am informed by the oldest settlers on this channel that the old Indians have told them that the river has not run through here for nearly a century. The use of this channel as the only outlet for the Nooksack River would be objectionable under the most favorable conditions, for the reason that the small craft which navigate the river would find it very dangerous reaching the cities on Bellingham Bay, having to pass through the rough water of the open Sound.

Survey at mouth.—Here at the mouth I made a careful instrumental survey, the results of which are shown on the accompanying map. I found the mouth of the last-used channel entirely blocked up by a jam of logs, snags, and drift 2,000 feet in length. At present about one-half of the water of the river flows under and through the jam, the balance being forced through a slough near by, known as "Steamboat Channel," and being thus divided, it flows over the mud flats without forming any definite channel. This jam will continue to increase in area and depth as time goes on. The great number of boom piles between the mouth and deep water is, I think, largely responsible for the forming of this jam, though possibly not entirely so. The general tendency of this boom construction would naturally be to lessen the depth, thus causing large snags to ground which would otherwise have likely found their way out to sea, and, as will be seen from the map, the jam could not move out at high tide if it were afloat, on account of being so confined by the boom piles. Until about four years ago the main channel flowed through "McDonalds Slough," but this is now very shallow and about dry at low tide.

As a means of overcoming the difficulties at the entrance to the river two plans are suggested:

If practicable, the most advisable plan, on account of its straight channel, would be that of cutting out and removing the north 1,000 feet of the present jam, together with what piling and boom construction might go with same, and the construction of pile dikes and revetments, as shown by the accompanying sketch, designated Plan A.

The second plan is that of throwing all the water into Steamboat Channel, allowing the present jam to remain as it is. This would necessitate the construction of pile dikes across the present mouth and also at the head of several other sloughs, as shown on the accompanying sketch, designated Plan B.

In the construction of either plan means should be provided for letting logs through the dike at the present mouth into the boom.

With all the water of the river confined and concentrated in one channel, I believe that it would very soon scour out the sand, giving sufficient depth to accommodate such light-draft boats as would navigate on the Nooksack River.

Regarding the shipping on the river, I am informed by ranchers who have farms adjoining that it would be of great advantage to them if they could ship by boat to the cities on Bellingham Bay and other points on the Sound, instead of having to depend upon teams. One rancher, living near Lynden, shipped his crop of potatoes in 1892 to Seattle on the steamboat *Minnie M*, which was then on the river, and it cost him but $4 per ton, and it now costs him about the same by team to Whatcom. Freight rates by team from Lynden to Whatcom are $3 to $5 per ton, while I am informed that it could be handled by steamboat for $1 per ton The last boat able to get up river reached Lynden about April 1, this year.

The accompanying maps, transmitted herewith, form part of this report, all of which is very respectfully submitted.

DAVID B. OGDEN, *Assistant Engineer.*

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

T T 37.

PLANS AND ESTIMATES FOR THE IMPROVEMENT OF THE KOOTENAI RIVER, IDAHO.

[Printed in House Ex. Doc. No. 233, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., January 19, 1895.

SIR: In accordance with the requirements of the river and harbor act of August 17, 1894, a survey of Kootenai River, Idaho, was made by Capt. T. W. Symons, Corps of Engineers, and I have now the honor to submit the accompanying copy of his report, dated January 1, 1895, upon the subject.

The plan of improvement proposed by Captain Symons contemplates removal of snags and overhanging trees from the river between Bonners Ferry and the international boundary line, at a total estimated cost of $5,000.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., January 1, 1895.

GENERAL: I have the honor to submit the following report in reference to the Kootenai River, required by your letter of September 1, 1894.

The terms of the law relating to this item are as follows:

The Secretary of War is hereby directed to prepare and submit plans and estimates for the improvement of the Kootenai River, Idaho, as recommended by Captain Symons in the preliminary examination submitted by him under date of October twelfth, eighteen hundred and ninety-two.

The substance of my report on the preliminary examination was that the Kootenai River was worthy of improvement to the extent of removing the snags in the river which are dangerous to navigation or liable to become so.

Investigation reveals the fact that the condition of the river is practically the same as when my former report of October 12, 1892, was written. There is a large but uncounted number of snags which interfere to a greater or less extent with navigation. There is a number of trees along the banks which are being undermined and will soon be in the river. It is believed that the best and most economical method of removing these snags and overhanging trees will be by hiring one of the steamboats on the river, provided with a steam capstan and with an ample supply of lines and blocks to do the work. Such a boat, in connection with a liberal supply of giant powder for breaking up such snags as are beyond the power of the boat to handle otherwise, will enable the work of clearing out the river to be done expeditiously and cheaply.

It is estimated that a boat properly rigged up will require about three months to remove all the snags and overhanging trees between Bonners Ferry and the boundary line. Such a boat with a full crew will cost about $1,200 per month.

Estimate.

Hire of steamer for three months, at $1,200		$3,600
1,000 pounds of giant powder, at 30 cents		300
Extra rope and tackle		200
		4,100
Engineering and office expenses		900
Total		5,000

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., January 8, 1895.

Respectfully forwarded. Recommended.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

T T 38.

SURVEY OF GRAYS HARBOR AND ITS BAR ENTRANCE, WASHINGTON, WITH A VIEW TO THE IMPROVEMENT OF ITS CHANNELS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., March 20, 1895.

GENERAL: I have the honor to submit the following report on the survey of Grays Harbor and its bar entrance, Washington, "with a view to the improvement of its channels," and estimates of the cost of improvement.

Report.—The inner portion of Grays Harbor having been the subject of a special examination and survey, and being under improvement with an appropriation specially made therefor, the above-quoted item in the river and harbor bill is interpreted to refer exclusively to the entrance to the harbor.

The survey of the harbor entrance was made by Mr. J. M. Clapp, assistant engineer, in October, 1894. The results of his survey are shown on the accompanying map of the entrance to Grays Harbor, and upon which is indicated the location of the jetty proposed for the improvement of the entrance.

The soundings on the map are in feet, and are referred to the mean of the lower low waters.

The survey shows maximum depths in the harbor throat of 100 feet.

A single broad waterway extends for more than 2 miles from the harbor throat out to sea, with depths gradually diminishing from 100 feet to 30 feet.

Between this deep waterway and the open sea lies the usual bar, convex to the sea and connected with the spits which jut out from Points Brown and Hanson. The spit from Point Brown is known as the North Spit, and that from Point Hanson is South or Trustee Spit.

Across this bar there is no well-defined, decided, permanent channel. The best water was found at the time of the survey to be in a line southwesterly from Buoy No. 2. This was the channel used by tugs and boats entering the harbor, and was marked by a mid-channel buoy. The survey shows that fully as good a channel existed to the east of this, running more nearly due south. There is also shown nearly as good a channel to the northwest, and also a fairly good one nearly due west.

The governing depth on the bar in the south and southwest channels shown was 13 feet at mean lower low water. In the northwest channel it was 12 feet.

The general average distance between the inner and outer 18-foot curves is one-half mile. The region between the two curves was found to be irregular with lumps and depressions.

Upon the map is given a cross section of the harbor throat from Point Brown to Point Hanson, and also a profile through the harbor throat and outer waterway, and along various lines across the bar.

There is also given upon the map a longitudinal profile of the proposed jetty, and an enlarged cross section of the same.

A vicinity map is given on the same sheet.

General description.—The entrance to Grays Harbor from the Pacific Ocean lies in latitude 46° 55′ north, being 45 miles north of the mouth of the Columbia River.

The harbor has a length from east to west of 17 miles, and from north to south a maximum breadth of 14 miles. There are a number of

rivers tributary to the harbor, the principal ones being the Chehalis, Satsop, Wynooche, Wishkah, Hoquiam, and Humptulips, all of which come from the east and north. There are two main channels crossing the harbor from east to west—the north and south channels, of which the north channel is the principal one and the one undergoing improvement at its upper end.

A large part of the harbor is occupied by tide flats, bare at low water. The total tidal area of the harbor is estimated at 96.8 square miles. At low tide the area covered by water is estimated at 30.6 square miles, or less than one-third of the total area. The average range of the tide is 8.4 feet, with a maximum range of 12.9 feet.

The low-water area consists of a number of channels running through and between mud and sand flats. The banks of these channels are quite steep, so that the water does not begin to overflow the flats until it has risen about 2 feet above mean low water. At about 5.2 feet above mean low water, the flats are completely covered. Between this stage and mean high water, there is no considerable increase in area.

From the best data available, it is estimated that the volume of water displaced during a mean tide of 8.4 feet, is 16,000,000,000 cubic feet. Assuming the tide to run out for six hours, this gives an outflow of 748,000 cubic feet per second.

The volume of water displaced during a maximum tide amounts to 24,000,000,000 cubic feet, which, assuming the run out to cover six hours of time, makes a discharge of about 1,100,000 cubic feet per second.

The harbor throat lies between two low, sandy peninsulas, terminating on the north of the entrance in a point known as Point Brown and on the south of the entrance in a point known as Point Hanson. The distance between high-water lines on these two points was, at the time of Mr. Clapp's survey, 12,500 feet. These points have at times had names differing from those mentioned above. Locally, the north point is often spoken of as Damons Point and the south as Petersons Point.

On the north of the entrance the extreme limit of Point Brown is a ribbon of sand partially encircling the main higher land, and separated therefrom by a tidal lagoon called Johns Bay.

The same peculiar formation, but less marked, exhibits itself on the south. Maps of the entrance made at different periods show marked changes in the formation about these limiting points.

There seems to be a definite cycle of changes in the end of the north spit abreast of the harbor throat. First, there is an island near the deep water shown on the 1862 map as Eld Island. This island gradually works to the north and finally attaches itself to and encircles Point Brown, as shown on the 1883 and 1891 maps. This ribbon gradually wears away as shown on the 1894 map, and as this proceeds the island begins to form near the deep channel toward Point Hanson. This island is now in process of formation, although it was not possible at the time of the recent survey to get any definite soundings on it to show it on the map. It is however indicated in position.

The changes about Point Hanson are less in extent than those about Point Brown. The 1862 map shows an extension of the Point Hanson sands farther to the north than they appear at any subsequent period.

Deep water in the harbor throat lies next to Point Hanson and occupies about one-third of the width between it and Point Brown. The other two-thirds is occupied by the changeable sandspit above described, which is partly bare at extreme low tide. In the harbor throat the

flowing waters have gouged a deep hole. The greatest depth found by Mr. Clapp was 100 feet, but depths as great as 106 feet are shown on some of the Coast Survey charts.

The cross-sectional areas of the channel between Points Brown and Hanson are as follows:

	Square feet.
At mean high tide	293,760
At mean tide	245,960
At mean low tide	200,560

This would give, in an ordinary tide, an average velocity through the harbor throat of 3.04 feet per second, or about 2 miles per hour. In a maximum tide this average velocity would be increased to 4.47 feet per second, or about 3 miles per hour.

Points Brown and Hanson are the terminations of low peninsulas which separate Grays Harbor from the ocean.

The Point Brown Peninsula is about 7 miles long and the Point Hanson Peninsula about 4 miles long. Both average about 1 mile in width, and both are covered with a dense jungle of timber to within about a mile and a half of their extreme ends.

In front of the entrance to Grays Harbor the 100-fathom curve lies 32½ statute miles from the general shore line. The 10-fathom curve lies 4½ statute miles in front of the general shore line. This gives a general slope to the ocean bed in front of the harbor of 3.2 fathoms or 19.2 feet per statute mile. The 10-fathom curve lies but about 3,000 feet in front of the outer 3 fathom curve of the bar. This gives a very steep slope in front of the bar of 1.4 feet in 100 feet, a slope which is very conducive to the success of the plan of improvement proposed, as the bar will not be readily formed in advance of its present position after a deep channel is scoured across it.

The Grays Harbor Bar projects beyond the general coast line in a crescent shape, as is well shown on Coast Survey charts Nos. 6100 and 6400. The material of the bar is a fine gray sand.

Directly opposite the entrance the outer 3-fathom curve is beyond the middle of the harbor throat, a distance of 4 miles.

The general distance between the inner and outer 3-fathom curves varies greatly, but it may be said to be approximately one-half mile in the vicinity of the bar channel.

From the most accurate information available, it is ascertained that the best bar channel varies in depth from 12 to 20 feet, and in direction from nearly south to northwest.

As nearly as can be ascertained it is learned that there is a great cyclic change in the bar channel, occurring in about thirty-five to forty years, and a lesser one occurring at short and irregular intervals.

The greater movement seems to follow or be coexistent with the building up and movement of the sand island off the southern end of Point Brown. When the island is well formed the best entrance channel is to the northwest, and as the island travels north the channel travels south. The entrance channel is at its best when leading out to the southwest.

From this position it swings gradually around to the south, until it reaches a direction that is nearly due south. As this movement takes place the channel becomes deeper, but narrow and crooked, and immediately following this it breaks out to the west and commences to swing around to the southward again. The smaller movement, from west around to south, occurs many times more than the greater.

This cyclic movement of the channel has an important bearing upon the plan of improvement recommended.

During the winter, when the southwest storms prevail, the water is deeper in the entrance channel than during the summer. This is attributed to the heavy freshets more than counteracting the efforts of the storm to close the bar. The bar channel closes to some extent during the summer, when the milder northwest winds prevail, when the sands of the higher spits and beaches are dry, when the ebb and flow of the tide is small, and when there are no freshets.

Littoral current.—In the vicinity of Grays Harbor there is a littoral current, the general resultant of which tends to the north.

This general current to the northward is ordinarily considered as the eddy caused by the southward flowing Japanese Gulf Stream. It is noted all along the coast and has received the name of the Davidson Inshore Eddy Current.

While the resultant littoral current is to the north, it ordinarily follows the direction of the prevailing winds, moving to the southward in summer and to the northward during winter. In intensity it is said to reach as high as $2\frac{1}{2}$ miles per hour either way.

Surveys.—There have been five surveys of the Grays Harbor entrance made, covering a period of thirty-two years. Three were made by the Coast Survey in 1862, 1883, and 1891, and two by the U. S. Engineer Department, 1881 and 1894.

Charts of the first four of these surveys, reduced to the same scale, $\frac{1}{40000}$, are herewith. The survey of 1894 is shown on a separate map on a scale of $\frac{1}{20000}$.

The bar and bar channel shown on all these charts are similar, except those shown on the 1862 chart.

In 1862 the bar channel was to the northwest of the harbor throat; in all the others it is to the southwest. The complete charts of 1891 and 1894 show the bar to be in a lumpy condition. The survey of 1894 shows almost as good water in a nearly due south course as in the southwest course, and it is understood that pilots are now using this southerly channel. It also shows almost as good water in a westerly and northwesterly direction as in the channel to the southwest. The survey of 1862 shows but one channel, the one leading to the northwest. It is quite possible, and in my opinion very probable, that a good channel existed also to the southwest, although not shown on the chart. The survey was made in a sailing brig, and the soundings were apparently almost entirely confined to the waterway leading out to the northwest, which was probably the best-known channel at the time. No soundings are shown to the south and southwest.

There is another condition bearing upon the question of improvement which is not fully shown on the charts. This is the existence of a channel leading to the south around and close in to Point Hanson. This is indicated on the map of 1862, and slightly on the map of 1881, and was observed but not surveyed by Mr. Clapp in 1894. It is marked on his map as Canoe Channel from the fact that it is used by fishermen and and others going in and out in small boats in smooth weather.

Plan of improvement.—The plan proposed for the improvement of the entrance to Grays Harbor is based upon the theory of controlling the ebbing and flooding waters to a sufficient extent to concentrate and direct upon the bar in a fixed location a much greater portion thereof than would naturally go there, thereby scouring a channel across the bar of depth ample for all purposes of navigation and permanent in position.

The large tidal volume and discharge from Grays Harbor furnish the means, if properly directed, to secure a bar channel of satisfactory

depth. The ordinary mean tidal discharge is estimated at 748,000 cubic feet per second. Its tremendous scouring effect is shown at the harbor throat, where, as long as the harbor has been known, depths of 100 feet have been maintained.

It is recognized that in order to produce a satisfactory channel it is necessary to add to a natural channel but a limited proportion of the ebbing and flooding waters now going elsewhere, provided these waters can be kept flowing there permanently. In other words, it is by no means necessary, as it is not desirable, to direct all the ebbing and flooding waters into a single narrow bar channel.

It is also recognized that the safety of any controlling works demand that but a small proportion of the flowing waters be fully controlled by artificial means.

Based upon the ordinarily accepted theories of harbor improvement, as shown by the plans adopted for various places in the United States, the plan for Grays Harbor would be to confine the outflowing and inflowing waters between two jetties more or less parallel and converging upon the bar to a sufficient distance apart to concentrate and direct the waters in a single bar channel.

Recent experiences and consideration of the subject convince me, however, that at Grays Harbor this ordinary plan can be deviated from, and that one jetty, if properly located, will accomplish results fully as good as two, at a vastly less cost and without any undue or destructive strain upon the structure from the developed currents.

At Coos Bay, the one jetty that has been built has caused a bar channel to be developed and maintained fully equal to that which it was hoped to accomplish with two jetties. There the jetty has been interposed against the slow, constant movement of the bar channel to the northward. The plan proposed for Grays Harbor is based largely upon the results obtained and studies made at Coos Bay.

At the mouth of the Columbia the single jetty has been eminently successful. Here there is a rocky headland on the north, and the situation is apparently quite different. In reality, however, it is much more similar than appears at first sight, for the limiting of the waters to the north of the bar channel is due not to the Cape Disappointment headland but to Peacock Spit and its tailing sands. There are many points of resemblance in the Grays Harbor problem to that at the Columbia River.

The plan proposed for the improvement of Grays Harbor entrance consists of a single high-tide rubblestone jetty founded on Point Hanson and directed out to sea as shown on the plot.

The receiving wharf is located on the south channel inside the harbor sufficiently far to enable stone scows, etc., to be unloaded in safety.

The jetty tramway approach thence extends nearly due west 7,300 feet across the head of Point Hanson; the jetty commencing at the high-tide line extends still nearly due west 10,900 feet along the South or Trustee Spit at a distance of about 1,000 feet from its outer steep slope, cutting off the inner coast or Canoe Channel. Leaving Trustee Spit it curves to the southwest for 7,300 feet, reaching the crest of the bar at about the present location of the mid-channel bar buoy. Here it stops.

With this location the water flowing to the southward through the inside coast channel over Trustee Spit and beyond this to the end of the jetty would be stopped from flowing in its present direction and compelled to go in and out to the north of the jetty. It is believed that these deflected waters added to the natural waters of the desired chan-

nel location will give an improved bar channel sufficient for all purposes of navigation.

With the jetty in this location the slow cyclic movement of the bar channel would be stopped when the latter reaches its best and most satisfactory position, and it is believed that the jetty would maintain it in this position. The jetty would prevent the channel from moving toward the south and there would be no occasion for it to "break out" to the west or northwest.

The exposed end of the jetty would be nearly head on to the worst storms, those from the southwest, an important point in maintaining its stability. The slightly curved direction given to the jetty trace, convex to the channel, will give to the channel whatever advantage there is due to the tendency of tidal flows to follow a convex curve. The channel would also have the direction and location most convenient and desirable for the commerce centering in the harbor.

On the direct line from Point Brown to Point Hanson, the line upon which the greatest depth is found, the midtide section has an area of 246,000 square feet. The maximum depth on this line is about 100 feet, a depth entirely inadmissible in the vicinity of jetties unless the jetties be protected by long and costly groins.

If a system of double jetties were adopted it would be necessary to provide a minimum waterway between them fully equal to 246,000 square feet. Assuming an average midtide depth of 20 feet this would require that the jetties should be spaced $2\frac{1}{3}$ miles apart, if built to high tide.

If this width were narrowed there would be a tendency to dangerous undermining of the jetties, which would increase as the width diminished. Within this necessary width of over 2 miles there would undoubtedly develop one or more channels of much greater depth than 20 feet at midtide. Such a channel might occupy any position between the jetties, and on leaving the concentrating influence of the jetties would have almost as great latitude in choosing its direction as would be the case of a channel with but a single jetty as directrix. It is therefore believed at the present time that it is unnecessary to provide a north jetty or to make provision or estimate for any other construction than as herein indicated.

It is proposed that the jetty shall be extended to the ordinary crest of the bar in its present location. This would give a total length for the structure of 25,500 feet from the receiving wharf to the end.

Of this there would be 7,300 feet of simple tramway construction across Point Hanson, 10,900 feet across Trustee Spit, where the water is comparatively shallow, and 7,300 feet in water from 6 to 22 feet deep at low water.

The jetty which is estimated for is similar in all essential respects to those built at the mouth of the Columbia, at Coos Bay, and elsewhere. In brief, it would consist of a rubble mound of large and heavy stone built upon a foundation of brush mattress from a pile and timber tramway.

The following points bearing on the estimates of cost are submitted:

Plant.—The plant required for the proper and economical conduct of the work of building a jetty from Point Hanson for the improvement of Grays Harbor, provided the work is carried on in a similar manner to that at the Columbia River and Coos Bay, is as follows:

Wharf.—A wharf would have to be built in some convenient sheltered location inside the bay—about in the location shown. Such a wharf should be built about 50 by 250 feet in size and 15 feet above ordinary high water, and provided with the requisite turntables and track approaches. Its estimated cost is $7,000

Land, etc.—Land and wharf rights and right of way privileges across the end of the Point Hanson peninsula it is estimated will cost $5,000
Derricks.—Two derricks at $250 each will cost 500
Hoisting engines.—Two 10 by 16 inch double-cylinder hoisting engines, at $1,700 each 3,400
Locomotives.—Four locomotives of about 13 tons each would be required; these, at $3,500 each, would cost 14,000
Dump cars.—Forty geared dump cars would be required, at $450 each 18,000
Flat cars.—There would be required for the mattress work and various other purposes, 8 flat cars, at $275 2,200
Push cars.—Two push cars at $40 would be required 80
Hand car.—One hand car at $75 would be required 75
Pile driver.—One revolving pile driver for constructing the jetty tramway would be required. This it is estimated would cost 9,000
Tender car.—A tender car for supplying piles, lumber, etc., to the driver would cost about 800
Mattress maker.—A movable derrick apparatus for handling the small trees and making the mattresses of them would be required. This it is estimated would cost, with hoisting engine, etc 3,000
Water supply.—The water supply would probably be pumped from driven wells by a special pump and boiler, all of which, with tanks properly located and the necessary piping, would cost about 3,000
Machine shop.—It would be requisite to have a shop supplied with the tools necessary for making needed repairs to the plant. Such a shop with a boiler and engine, machinery, and tools, would cost 5,000
Tools and appliances.—The tools and appliances required for the proper conduct of the work would cost 5,000
Storage platforms.—It is estimated that 150,000 square feet of gridiron would be required for the storage of piles, lumber, etc. This, at 2 cents per square foot, would cost 3,000
Office building.—A suitable office building would cost 1,200
Other buildings.—A roundhouse, coal bunker, and houses over the hoisting engines and pump, and car shed would cost about 3,500
Shops.—Blacksmith, carpenter, and general repair shops would cost 2,500

Living accommodations.—The proximity of the work to the town of Westport, where all employees could find living accommodations, would obviate the necessity of providing special living accommodations at the works.

Floating plant.—There being no stone suitable for jetty work on Grays Harbor or in its immediate vicinity it would probably be necessary to take it by water from the Columbia River. For this purpose it would be requisite to provide at least five seagoing model barges, each capable of carrying in its hold 1,200 tons of rock on a draft not exceeding 10 feet. The barges would have to be provided with very large hatch accommodations for the facility of loading and unloading, and everything would have to be made snug and tight for the sea trip.

It is estimated that these barges fully completed and provided with anchors, chains, lines, living accommodations for the bargemaster, etc., would cost $13,000 each, or for the five, $65,000; two deck-barges for lumber, wood, brush, etc., at $1,200, $2,400; small boats, $300; total for floating plant, $67,700.

This makes the cost of the plant as follows:

Wharf $7,000
Land, rights of way, etc 5,000
Derricks 500
Hoisting engines 3,400
Locomotives 14,000
Dump cars 18,000
Flat, push, and hand cars 2,355
Revolving pile driver 9,000
Tender car 800
Mattress maker 3,000
Water supply 3,000
Machine shop 5,000

Tools and appliances	$5,000
Storage platforms	3,000
Office building	1,200
Other buildings	3,500
Shops	2,500
Floating plant	67,700
Total	153,955

It seems proper to invite attention to the fact that at the mouth of the Columbia River there is a full plant and equipment for carrying on jetty work, and that the work at this point is practically completed. This plant has very little value except for jetty work. If it could be used for the Grays Harbor work the cost of the plant which it would be required to build or purchase would be reduced to a sum not exceeding $100,000. Of this the stone barges would cost $65,000, the barges used in the Columbia River work not being suitable for the sea trip to Grays Harbor. There is also a good plant at Yaquina Bay, where the operations of jetty building are about completed, and which is, in the main, only valuable for similar work elsewhere.

The tramway.—The tramway would be in the main like that at the Columbia River and Coos Bay. It would be built with a revolving hydraulic pile driver, running upon the double-track railroad, upon which the supplies would be carried to the front, and upon which the stone dump cars would run.

At the Columbia little trouble has been experienced due to the ravages of the teredo. At Grays Harbor trouble from this source must be expected, as the relative amount of fresh water coming into the harbor is not sufficient to prevent its action. This is a strong reason why the work, if once undertaken, should be pushed to completion at the earliest practicable date before the wharf and tramway are destroyed.

In estimating the cost of the tramway diagonal bracing is left out, as experience teaches that it is of little, if any, value, and in some aspects is a positive detriment. In the outer deep-water portion additional strength is given to the tramway by strapping the caps to the piles with iron straps 2½ inches wide and three-eighths inch thick.

At Grays Harbor first-class piles can be had for 4 to 5 cents per foot, and excellent lumber for $6 to $8 per 1,000 feet, B. M., delivered.

The following is the detailed estimated cost of the tramway:

Estimated cost of tramway per 16-foot bent across Point Hanson.

Four 25-foot piles, 100 linear feet, at 5 cents	$5.00
Lumber, 1,480 feet, B. M., at $8	11.84
Steel rails, 640 pounds, at 2½ cents	16.00
Joints for rails, 2, at 40 cents	.80
Railroad spikes, reverse points, 24 pounds, at 3 cents	.72
Driftbolts, 1-inch and 1⅛-inch, 60 pounds, at 3 cents	1.80
6-inch spikes, 5 pounds, at 3 cents	.15
Handling and storing lumber and piles	2.00
Labor, building tramway	11.60
Total cost of 16-foot bent	49.91
Cost per foot	3.12

For the section across Trustee Spit this cost, due to increased length of piles and greater cost of labor in building, would amount per bent of 16 feet to $56.31, or $3.52 per linear foot.

For the outer section in deep water, due to the same and the further necessity of strapping the caps to the piles, the cost per bent would be $70.44, or $4.40 per linear foot.

The cost of the tramway is estimated, therefore, as follows:

Point Hanson section, 7,300 feet, at $3.12	$22,776.00
Trustee Spit section, 10,900 feet, at $3.52	38,368.00
Deep-water section, 7,300 feet, at $4.40	32,120.00
Total	93,264.00
To this must be added a percentage to cover the cost of switches, turnouts, cross overs, head enlargement, accidents, delays, etc This is estimated at 10 per cent	9,326.40
Total cost of tramway	102,590.40

The wharf should have an elevation of 15 feet above ordinary high tide, and the tramway should have an upgrade sufficient to reach an elevation of 22 feet above high tide when it comes to deep water. This elevation would continue to the end.

Mattress foundation.—The available supply of brush at Grays Harbor is very limited, and mattresses like those built at the mouth of the Columbia and at Coos Bay are hardly practicable. There is, however, in convenient localities a large amount of small spruce trees from 4 to 8 inches in diameter at the butts and 60 to 80 feet long. It is believed that these trees can be converted into an excellent foundation mattress. By laying them with the tops toward the channel the required degree of flexibility would be obtained.

An excellent and convenient way of making the mattress would be by laying the small trees diagonally to the direction of the jetty, crossing each other at right angles, and all firmly bound together.

The mattress required for crossing Trustee Spit will cost, it is estimated, $3 per foot, and that required for the deep-water section will cost, it is estimated, $4 per foot.

Trustee Spit mattress, 10,900 feet, at $3	$32,700
Deep-water mattress, 7,300 feet, at $4	29,200
Total	61,900

Enrockment.—After careful and diligent search the conclusion has been forced upon me that there is no stone suitable for jetty construction in the vicinity of Grays Harbor. Neither can I ascertain that suitable stone exists along the line of the railroad running to the harbor within a reasonable distance.

The most available and surest stone supply seems to be from the Columbia River, and in making the plans and estimates this source of supply is assumed.

Assuming also that the stone is taken from the same point as that for the Columbia River Jetty, the stone for the Grays Harbor work will have to be towed 95 miles down the Columbia to Astoria, out across the Columbia River Bar, 45 miles by sea, and across the Grays Harbor Bar, and into the harbor, a total distance of 160 miles.

Deck barges can not be used. The stone will have to be carried in the hold of barges which will be required to be completely and tightly decked over for the ocean trip.

The work of supplying stone to the jetty naturally divides itself into four parts:

1. Quarrying and loading it on the barges.
2. Towing to mouth of the Columbia River and returning empty barges.
3. Towing from the mouth of the Columbia to Grays Harbor and returning empty barges.
4. Unloading the stone and hauling and dumping it in the jetty.

Each of these items has been specially investigated, and a fair and liberal estimate of the cost is as follows:

	Cents.
1. Quarrying and loading, per ton	55
2. Towing to mouth of river, per ton	15
3. Towing to Grays Harbor, per ton	15
4. Putting in jetty, per ton	12
Total	97

It must be borne in mind, however, that delays are very liable to occur and accidents to happen in this part of the work, and it is therefore deemed proper to increase this estimated cost of stone by 10 per cent to cover such contingencies. This will make the stone cost in the jetty $1.07 per ton.

In estimating the amount of stone required for the jetty it is assumed that the bottom along the line of the jetty will remain unchanged, that the foundation mattresses will just about compensate for the inevitable scour in advance of construction, and that the top of the enrockment when completed will slope from an elevation of 7 feet above high water on Point Hanson down to an elevation of 4 feet above high water at the outer end. It is also assumed that at the end the enrockment will be doubled for 250 feet in length. The amount of stone required for each depth was determined from a study of the amounts used for corresponding depths in the Columbia River and Coos and Yaquina Bay jetties.

In this connection it is to be noted that the average depth of the water along the line of the proposed jetty is much less than that along the line of the Columbia River Jetty. The general average depth of the Columbia River Jetty below low water is 15.8 feet, while the general average depth of the proposed Grays Harbor Jetty is but 7.6 feet below low water.

The following table shows the lengths of the sections of different depths and the estimated tonnage for each section:

Length of section.	Depth of section at M. L. L. W.	Tonnage of stone, per foot of section.	Total tonnage of section.
Feet.	*Feet.*	*Tons.*	*Tons.*
1,900	22	52	98,800
800	21	49	39,200
700	20	47	32,900
600	19	44	26,400
500	17	39	19,500
100	16	37	3,700
400	15	35	14,000
300	14	32	9,600
500	13	30	15,000
1,800	9	22	39,600
500	6	17	8,500
2,500	5	15	37,500
4,700	3	12	56,400
1,900	0	10	19,000
1,000	(*)	8	8,000
18,200	.....	.....	428,100
250 feet end enlargement at 52 tons			13,000
			441,100

* Above low water.

441,100 tons, at $1.07 = $471,977.

Groins.—It will probably be found desirable and necessary to build some groins along the channel side in the deep-water portion of the jetty beyond Trustee Spit. The proper number, location, and length of

these can be best determined when the work is approaching completion. In order to cover the cost of the groins in this report, it is estimated that five will be required, each 200 feet long and 1,000 feet apart, the enrockment starting at high tide at the jetty and ending at low tide at the ends of the groins.

The tramway for these groins, at the maximum price for the main tramway, will cost, it is estimated—

1,000 feet, at $4.84	$4,840
Mattress for groins, 1,000 feet, at $4	4,000
Enrockment of groins, 30,000 tons, at $1.07	32,100
Total	40,940

Shore protection.—Experience shows that where a work like the one outlined for Grays Harbor is built and the natural conditions are changed to a greater or less extent that it is almost invariably found necessary to do some revetment work about the root of the jetty to prevent or limit destructive erosion.

The amount required can not be predetermined with any degree of accuracy.

At Grays Harbor, for the work as planned, it is believed that a great extent of revetment work will not be required.

In order to be on the safe side, however, it is estimated that there will be 5,000 feet of shore line requiring protection, which, at $3 per foot, will cost $15,000.

The summarized cost of the proposed improvement at Grays Harbor, as estimated, is as follows:

Plant	$153,955.00	
Tramway	102,590.40	
Mattress foundation	61,900.00	
Enrockment	471,977.00	
Groins	40,940.00	
Shore protection	15,000.00	
Engineering, superintendence, office expenses, etc., 5 per cent	42,318.12	
		888,680.52
For contingencies, accidents, delays, repair of plant and tramway, care of property, etc., 12½ per cent		100,085.06
		988,765.58
Making the cost of the proposed improvement, in round numbers		1,000,000.00

The plan proposed for the improvement of the Grays Harbor entrance, I believe, will give a permanent bar channel with an ordinary depth of at least 24 feet at the mean of the lower low waters. It is believed that good results will follow immediately upon the closing of the Canoe Channel, and the benefits would continue to increase as the jetty was extended to the front.

It is quite possible that after the work outlined is done it will be found desirable and necessary to control in some manner the movement of the sand and water to the north of the entrance. In just what this work will consist, if any shall be found necessary, it is impossible to tell at the present time. The building of the jetty will change existing conditions so that plans for other work can only be made intelligently after it has been demonstrated in what these changed conditions consist. While work to the north of the entrance may possibly be required, this is by no means certain. The south jetty as planned follows so closely, in the greater portion of its length, the natural tendencies as exhibited in the formation about the entrance that it is hard to conceive that it will have any effect in producing detrimental changes

to the north of the entrance. It will probably produce there a more permanent and stable condition of affairs than exists at present.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., April 4, 1895.

Respectfully forwarded to the Chief of Engineers.

It is true that for a year or more there has been a good entrance at Coos Bay with one jetty, but there is no certainty that this condition will continue. It is as yet hardly an argument for the sufficiency of a single jetty. If it were it would argue for a north instead of a south jetty, as herein proposed.

There does not seem to be any unusual difficulty to be apprehended in carrying the tidal expanse of Grays Harbor as a single stream to a point several miles seaward of the present gorge. A waterway about 4,500 feet wide will accommodate the ebb and flow with moderate velocities. This waterway may be created by two jetties extended from the shore with an interval of about 6,000 feet. The channel may be held in the determined position by groins 500 feet or more in length extended from each jetty. At the outer ends, where the exposure is great, the jetties may be beaten down, but even then the great mass of circulation will be between them.

With a single jetty the discharge is likely to occur in two or more partial channels—not unlike the existing conditions. The best assurance for a fixed and deep channel is afforded when the tidal expanse is discharged in one concentrated stream, of which there are several illustrations on the Pacific Coast.

For these reasons this project is regarded as insufficient.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

SUPPLEMENTAL REPORT OF CAPT. THOS. W. SYMONS, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., May 22, 1895.

GENERAL: I have the honor to acknowledge receipt of Department letter of April 12, 1895, * * * in regard to my project for the improvement of the entrance to Grays Harbor, containing Colonel Mendell's indorsement thereon, and I beg to submit the following supplemental report in reference thereto, as required by the terms of your letter.

Colonel Mendell says:

> It is true that for a year or more there has been a good entrance at Coos Bay with one jetty, but there is no certainty that this condition will continue. It is as yet hardly an argument for the sufficiency of a single jetty. If it were it would argue for a north instead of a south jetty, as herein proposed.

My belief in the efficiency of a single jetty at Grays Harbor is based fully as much upon the success of the single jetty as planned and constructed at the mouth of the Columbia as upon the success of the single jetty at Coos Bay, which is planned as one of a pair of converging and parallel jetties, but which alone has been successful in maintaining a bar channel, permanent in position and of greatly increased depth. From both of these successful examples I think it fair to argue that there is at least a reasonable probability that a single jetty, if properly located, will be successful at Grays Harbor.

In the conclusion that the success of the single north Coos Bay jetty argues for a north jetty at Grays Harbor I can not agree. The same conditions which at Coos Bay have rendered the north jetty effective in maintaining a deep and permanent channel over the bar exist at Grays Harbor, but are reversed. At Coos Bay the bar channel habitually broke out to the west and gradually worked around to the north, getting finally into an awkward trough channel nearly parallel with the coast. The jetty as built is interposed in the way of this gradual channel movement to the northward. It is to this fact that its good results in giving a permanent location to the bar channel are attributed.

At Grays Harbor the bar channel habitually breaks out to the west and gradually works around to the south, getting finally into an awkward trough channel nearly parallel with the coast. The proposed jetty is located to interpose itself in the way of this gradual channel movement to the southward with the hope and belief that the same resultant action which has been found at Coos Bay will be found at Grays Harbor, with the outcome of giving a deep, permanent, well-directed bar channel.

The situation at Grays Harbor in regard to exposure, latitude, bar changes, and volume of tide water is much more analogous to that at the mouth of the Columbia River than it is to that at Coos Bay. It is in fact very similar to the Columbia. At the Columbia a single south jetty has been projected and constructed and is eminently successful in giving a deep channel in a permanent location, and this notwithstanding the fact that the entrance between the end of the jetty and Cape Disappointment is over 3 miles in width.

I can see no good reason why the experiment which has been so successful at the Columbia should not be repeated at Grays Harbor, particularly when it will not in any manner interfere with the construction of other works if they be found necessary. The single jetty which I have proposed would be one of a pair of jetties, should such a pair be found necessary.

Colonel Mendell further says:

> There does not seem to be any unusual difficulty to be apprehended in carrying the tidal expanse of Grays Harbor as a single stream to a point several miles seaward of the present gorge. A waterway about 4,500 feet wide will accommodate the ebb and flow with moderate velocities. This waterway may be created by two jetties extended from the shore with an interval of about 6,000 feet. The channel may be held in the determined position by groins 500 feet or more in length extended from each jetty. At the outer ends, where the exposure is great, the jetties may be beaten down, but even then the great mass of circulation will be between them.
>
> With a single jetty the discharge is likely to occur in two or more partial channels—not unlike the existing conditions. The best assurance for a fixed and deep channel is afforded when the tidal expanse is discharged in one concentrated stream, of which there are several illustrations on the Pacific Coast.

I am compelled to state that I can not agree with Colonel Mendell in his remarks.

Nowhere on the Pacific Coast, nor on the Atlantic Coast, nor, so far as I am aware, in the world, has the attempt been made to control

between parallel jetties a tidal flow of anywhere near the magnitude of that at Grays Harbor, and I should view with great apprehension the attempt to build the jetties to control the tidal flow as outlined by Colonel Mendell. With an average tidal flow and the rivers tributary to the bay in their ordinary condition we should have, in a channel 4,500 feet wide and an average of 30 feet deep at low tide, a mean tidal velocity of 4.9 feet per second, or 3.3 miles per hour. In this case the maximum velocity would be about 6 miles per hour.

With a maximum tidal run out in such a channel there would be a mean tidal velocity of 7.2 feet per second, or 4.9 miles per hour, and a maximum velocity of about 9 miles per hour. This is without taking into consideration the rivers tributary to the bay, which would add considerably to the volume and velocity of the current if they were in a freshet stage.

Such velocities as these are, in my opinion, incompatible with safety when they result from the artificial contraction of a waterway by comparatively frail structures built upon shifting sands and exposed to the wave action on a very stormy coast. It must, I think, be admitted that such a great volume of water as that of Grays Harbor moving with the stated velocities and aided by wind and waves, is a tremendous power and liable to play havoc with any works exposed to its full force. This is to be avoided if possible, and it is with this end in view that I propose to control as small a portion of the flowing waters as possible consistent with attaining the desired end.

At the harbor throat, or gorge, the cross sectional area of the waterway at mid-tide is 245,960 feet, and here depths of 100 feet are regularly maintained. With a width of 4,500 feet, this same cross sectional area could only be obtained by an average depth throughout of 54 feet. It could, therefore, naturally be expected that between the jetties spaced as indicated by Colonel Mendell there would be depths exceeding 60 feet, which depths confined in the immediate vicinity of a rubble stone jetty founded on sand would be very threatening, even though the jetty be guarded by long and expensive groins.

At only two points on the Pacific Coast have systems of parallel jetties controlling the tidal expense in one concentrated stream been practically completed: at Wilmington and at Yaquina. At Wilmington the tidal flow is only $\frac{1}{120}$ of that at Grays Harbor, and at Yaquina only $\frac{1}{20}$ of that at Grays Harbor.

My experience is such as to convince me that it would probably be found impossible to build a second jetty at Grays Harbor within 6,000 feet of a first one by the ordinary method, which has been and is being used on this coast. As this second jetty would be built out the currents would scour a channel in front of it until the depths would become too great for the construction of a pile and timber tramway.

As the seas in the locality are too rough to permit of the construction of the jetty from floating plant there would be the necessity of devising new methods of construction, which would surely be far more expensive than those ordinarily used.

As indicative of the unusual magnitude of the work of improving Grays Harbor by a system of parallel jetties in the manner outlined by Colonel Mendell, I give herewith a table showing the mean range of the tide, the tidal area, the mean tidal discharge, and distance apart of the proposed jetties for Grays Harbor and other harbors of the United States, where jetties have been or are being constructed, concerning which I have been able to get information:

Locality.	Mean range of tide.	Tidal area.	Mean tidal discharge per second.	Distance between jetties at sea ends.	Remarks.
PACIFIC.	*Feet.*	*Sq. miles.*	*Cubic feet.*	*Feet.*	
Columbia River.....	6.2	* 140	1,000,000	18,900	High tide single jetty. Width between end of jetty and Cape Disappointment.
Grays Harbor.....	8.4	96.8	748,000	6,000	Reduced to about 4,500 feet by groins. Width proposed by Colonel Mendell.
San Diego.....	3.7	25.5	97,000	4,000	High tide single jetty. Approximate width between end of jetty and Point Loma.
Humboldt Bay.....	5.5	24	100,000	2,100	High-tide jetties.
Coos Bay.....	5.5	24	100,000	1,500	Do.
Yaquina Bay.....	7	5	38,000	900	Do.
Siuslaw River.....	5.2	5.4	30,000	600	Do.
Coquille River.....	4.1	3.6	15,000	600	Do.
Wilmington Harbor...	4	2.25	6,000	700	Do.
ATLANTIC.					
Galveston Harbor.....	1.1	450	250,000	7,000	Do.
Charleston Harbor.....	5.1	15	170,000	2,900	Low-tide jetties.
Cumberland Sound	6	27	202,000	3,900	Do.
Winyaw Bay	3.5	12	120,000	4,000	High-tide jetties.
St. Johns River.....	4.3	(?)	76,500	1,600	
Sabine Pass.....	1.4	120	50,000	1,700	Do.
Newburyport.....	7.5	(?)	(?)	1,000	Do.

* To Cathlamet.

I beg to invite attention to the fact that my project does not absolutely limit the work of improvement to a single south jetty. This is provided for as the first and primary requisite to the improvement of the harbor, and the belief is expressed that it will be found sufficient. It is further stated that—

> It is quite possible that after the work outlined is done it will be found desirable and necessary to control in some manner the movement of the sand and water to the north of the entrance. In just what this work will consist, if any shall be found necessary, it is impossible to tell at the present time, etc.

If in the future a north jetty, as outlined by Colonel Mendell, or any other work should be found necessary, it can be planned and estimated for in a much more rational and intelligent manner than it can be at present.

Colonel Mendell says, "With a single jetty the discharge is likely to occur in two or more partial channels." My contention is that even if this does occur, one of these channels will be determined in position by the jetty, be permanent in position, and deep enough for all purposes of commerce. If this is found to be the case, then the improvement will be sufficient.

The single south jetty at the mouth of the Columbia, acting in the same manner as the proposed south jetty at the entrance to Grays Harbor is designed to act, has effected the object of giving a good, single, permanent entrance channel to the Columbia, and I can see no reason why the same should not be effected at Grays Harbor.

I have laid down in dotted lines upon the map herewith the north jetty about as outlined by Colonel Mendell, 6,000 feet from the south jetty, as proposed. Five groins, each 500 feet long, are also shown. If such a structure should be built, it would be desirable to extend two of the south jetty groins to 500 feet in length, and to build two new ones, each 500 feet in length.

Based upon the same general plans, methods of construction, size of enrockment, and the present elevation of the bottom, the cost of this

north jetty, with groins, shore protection, and additional groins on the south side, is estimated at $1,363,309.

This estimate is based upon using the same plant as that provided for in the estimate for the south jetty, as far as practicable, and upon the assumption that it can be built by the same methods, which, if it be built after the south jetty, is questionable.

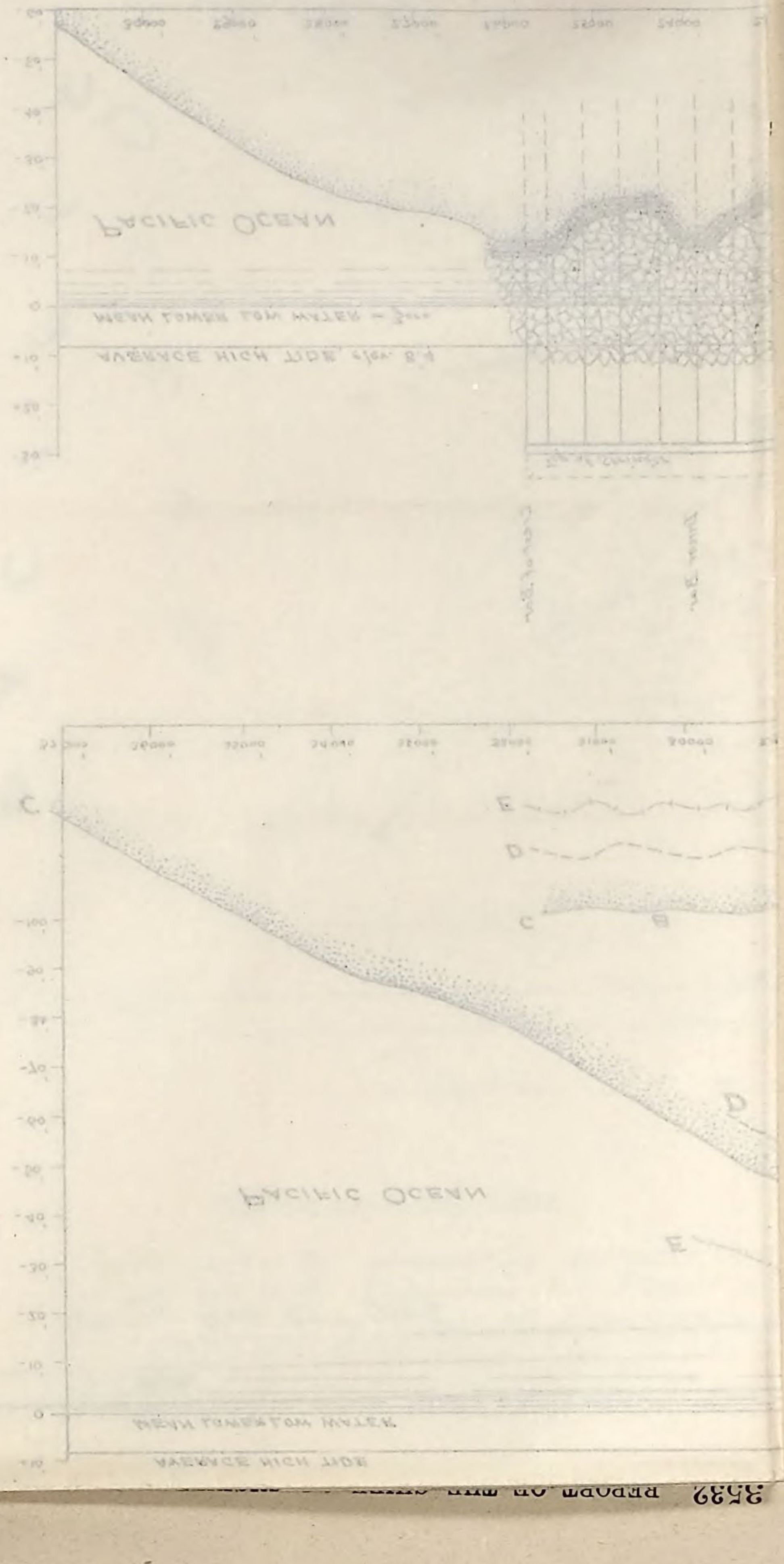
I submit this plan and estimate for a north jetty in accordance with Colonel Mendell's suggestion. It is my opinion that a north jetty is not necessary, but that if one is to be built its distance from the south jetty should be greater than the distance shown on the map.

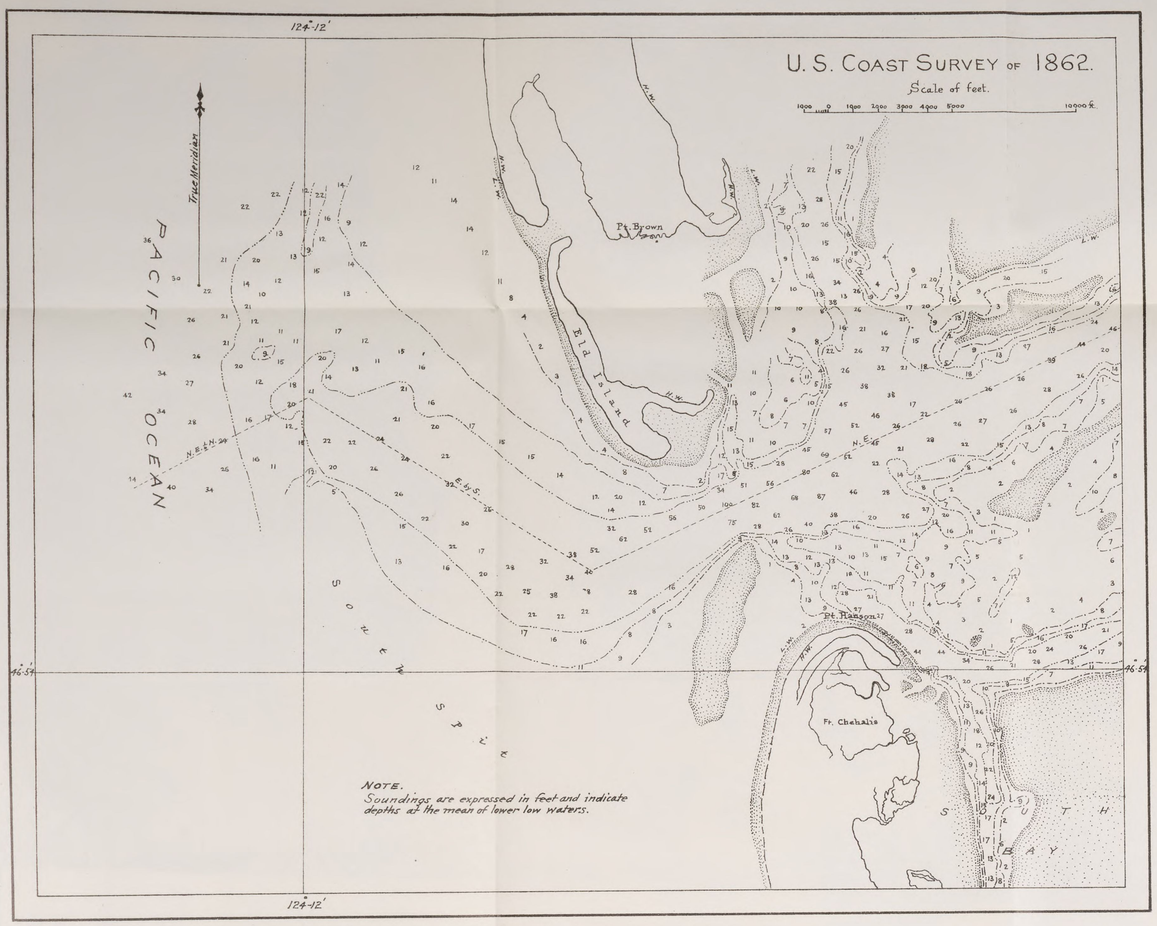
If this north jetty must be provided for in the plans and estimates, I submit that such provision should be only of a tentative character; that is, the jetty should only be built when it is demonstrated to be necessary, in a location to be hereafter determined, and then only far enough and high enough to accomplish the desired result.

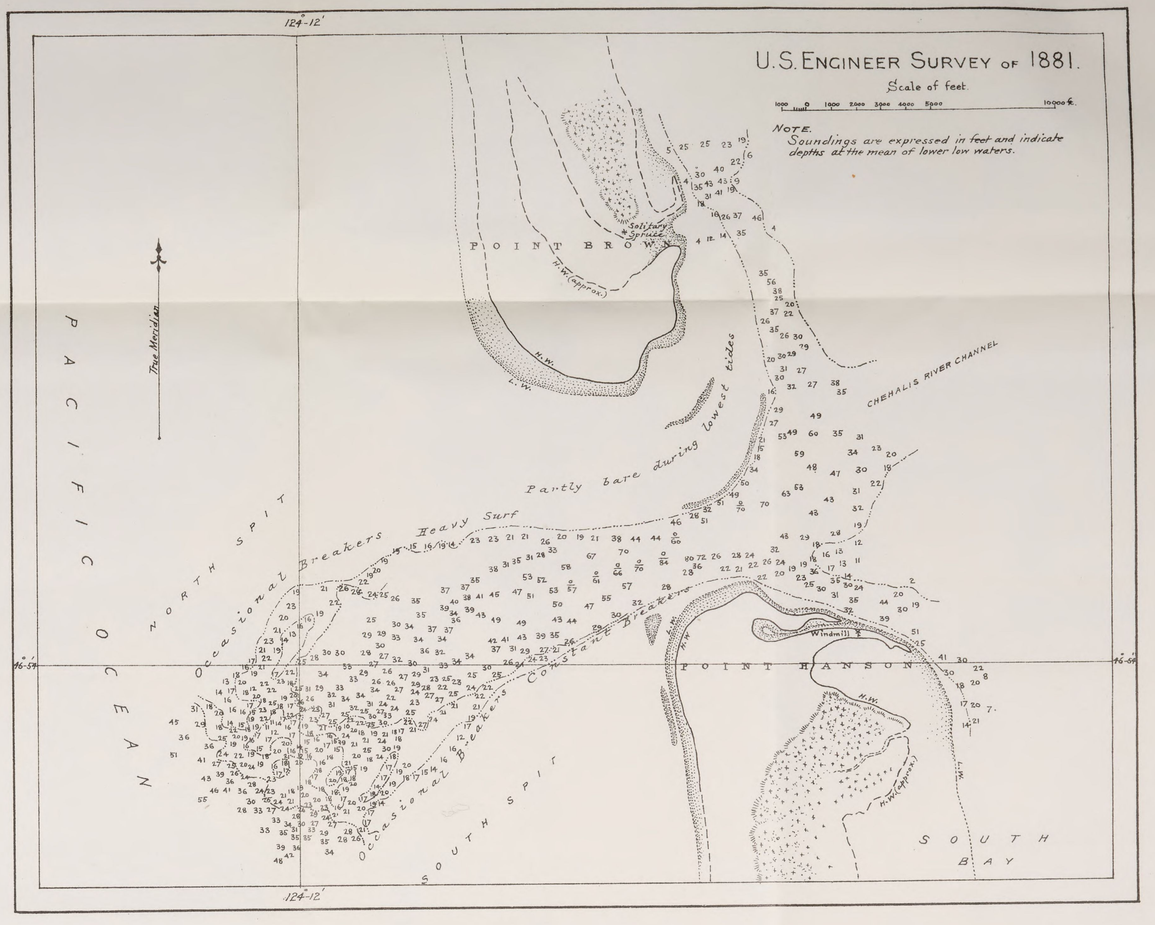
The following is the estimate of the cost of the additional work outlined by Colonel Mendell:

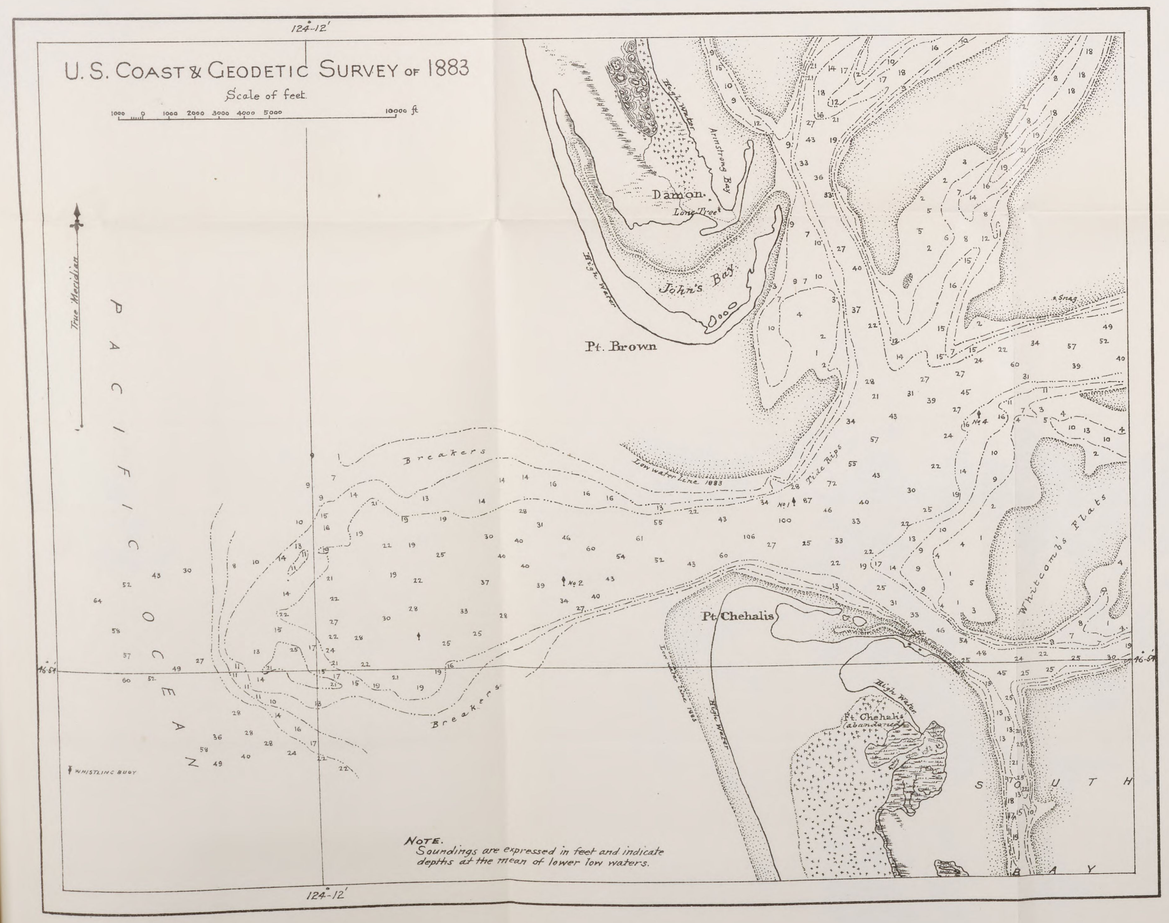
Plant:		
Removal and repair of plant		$10,000
Wharf		7,000
Land and rights of way		500
Water supply		3,000
Machine shop		2,000
Storage platforms		3,000
Office building		1,200
Barracks and mess house		3,000
Shops		2,500
Storehouses, etc		2,500
Total for plant		34,700
Tramway:		
10,000 feet at $3.52	$35,200	
15,625 feet at $4.40	68,750	
	103,950	
Add 10 per cent	10,395	
Total for tramway		114,345
Mattress:		
10,000 feet, at $3	$30,000	
15,625 feet, at $4	62,500	
Total for mattress		92,500
Enrockment:		
Stone in jetty, 690,831 tons; stone in end enlargement, 12,500 tons; 703,331 tons, at $1.07		752,564
Groins:		
North jetty—		
2,500 feet tramway, at $4.40	$11,000	
2,500 feet mattress, at $3	7,500	
84,500 tons stone, at $1.07	90,415	
South jetty (extra groins)—		
1,600 feet tramway, at $4.40	7,040	
1,600 feet mattress, at $3	4,800	
18,000 tons stone, at $1.07	19,260	
Total for groins		140,015
Shore protection:		
Shore protection, north jetty	$15,000	
Connection of jetty with main shore	5,000	
Total for shore protection		20,000
Total		1,154,124

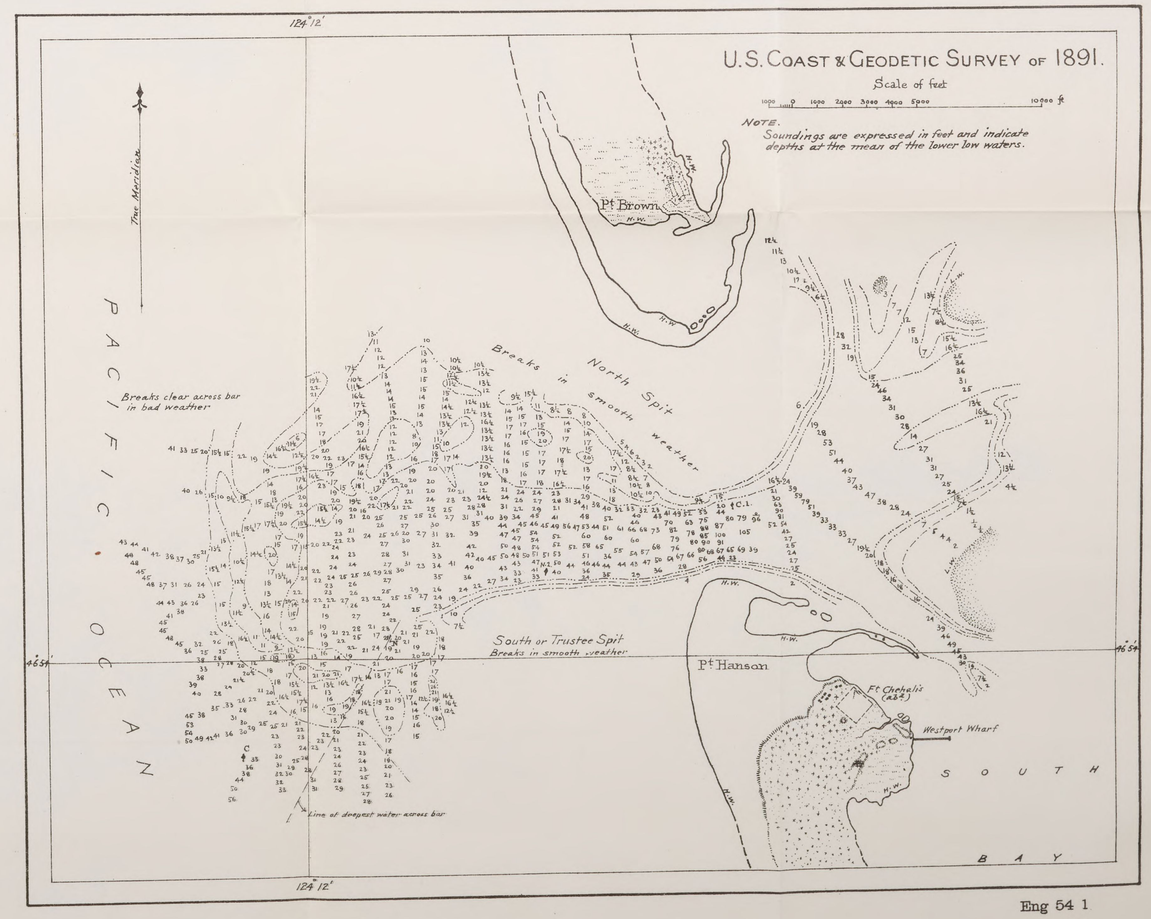
SOUTH CHANNEL


PACIFIC OCEAN
MEAN TONGAN TOW WATER
VARIANCE HIGH TIDE
A
B
C
D
E









Eng 54 1

CHARTS OF GRAYS HARBOR, WASHINGTON.

TO ACCOMPANY REPORT OF CAPT. T. W. SYMONS, CORPS OF ENGINEERS OF MAR. 1895.

Enrockment.—The following table gives the enrockment data for the north jetty as laid down in accordance with the plan outlined by Colonel Mendell:

Depth of section.	Length of section.	Stone per foot of section.	Total tonnage of section.	Remarks.
Feet.	*Feet.*	*Tons.*		
.....	7,290	6	43,740	Above low water.
2.....	417	11	4,587	Below low water.
3.....	417	12	5,004	Do.
4.....	417	13	5,421	Do.
5.....	417	15	6,255	Do.
6.....	833	17	14,161	Do.
7.....	417	18	7,506	Do.
8.....	417	20	8,340	Do.
9.....	417	22	9,174	Do.
10.....	417	24	10,008	Do.
11.....	833	26	21,658	Do.
12.....	417	28	11,676	Do.
13.....	417	30	12,510	Do.
15.....	1,250	35	43,750	Do.
16.....	1,250	37	46,250	Do.
17.....	833	39	32,487	Do.
18.....	3,333	41	136,653	Do.
19.....	2,500	44	110,000	Do.
20.....	833	47	39,151	Do.
21.....	2,500	49	122,500	Do.
Total ..	25,625	.....	690,831	

SUMMARY OF ESTIMATE FOR NORTH JETTY.

Plant	$34,700
Tramway	114,345
Mattress	92,500
Enrockment	752,564
Groins	140,015
Shore protection	20,000
Engineering, superintendence, office expenses, etc., 5 per cent	57,706
	1,211,830
Contingencies, delays, repair of plant and tramway, care of property, etc., 12½ per cent	151,479
Total	1,363,309

Adding to this $1,000,000 for the south jetty, makes the total for the two jetties $2,363,309.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., May 31, 1895.

Respectfully forwarded to the Chief of Engineers.

The project of improvement by two jetties is recommended, their exact location to be determined upon final approval of plans.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

T T 39.

SURVEY OF COLUMBIA RIVER, WASHINGTON, FROM ROCK ISLAND RAPIDS TO THE OKANOGAN RIVER.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., May 22, 1895.

GENERAL: One of the duties assigned to my charge by your letter of September 1, 1894, was the "Survey of the Columbia River, Washington, from Rock Island Rapids to the Okanogan River."

I now have the honor to submit the following report thereon:

The survey was made during September, October, November, and December, 1894, by Mr. C. F. B. Haskell, assistant engineer, whose report is herewith.

There is also herewith a map of the river surveyed, in three sheets, on a scale of 2,000 feet to the inch, together with a vicinity map on a smaller scale. Also a sheet of profiles showing the bed of the river and the high and low water slopes. Mr. Haskell's report, which is herewith, describes the methods pursued in making the survey, and gives such full and complete description of the river that it is not deemed necessary to repeat here. This portion of the Columbia is a water highway of considerable importance in connection with the transcontinental railroad line known as the Great Northern.

The valleys of the Okanogan, Methow, Chelan, and Entiat rivers, and a large portion of the Big Bend country, lying on the left bank of the river, can be reached by way of the river. All these are difficult to reach in any other way.

A special report of an examination of the Okanogan River has been made by me, and is contained in House Ex. Doc. No. 238, Fifty-third Congress, third session.

The portion of the Columbia covered by this report and the Okanogan are naturally to be considered together.

The Columbia River, from the mouth of the Okanogan to Rock Island Rapids, is 80 miles in length. In this distance it has a fall at low water of 176 feet, and at high water of 169 feet. This gives an average low-water slope of 2.2 feet per mile, and a high-water slope of 2.1 feet per mile. The difference in elevation of the river at high and low water stages varies from 40 to 60 feet at different localities. The river throughout has ample water for all purposes of navigation, and the only impediments consist in the swift currents, combined in some instances with rocks which are dangerous only by reason of the swift currents, which render maneuvering difficult and uncertain. The obstructions can be avoided, however, by careful piloting, and the strong currents can be steamed without lining and without much risk of damage except in certain stages in three places, i. e., Methow Rapids, Entiat Rapids, and Rocky Reach.

Methow Rapids.—At the Methow Rapids the river is narrow and deep; the right bank is high and precipitous, and covered with large masses of rock at the narrow parts of the rapids, the smaller rocks and finer material having been carried away by the violent current of the extreme freshets. The left bank presents a continuous bluff; the shore is irregular in its outline, being broken by high rock ledges projecting far out toward the channel. The indentations, or bays, in this shore are shoal at low water, and are filled with bowlders and projecting points of rock. Owing to the great depth of water in the channel at these rapids and the low declivity of the surface the cur-

rent is not a material obstacle to navigation at low water. At that stage and at medium stage the ascent can be made by steamers without difficulty.

At high water, however, the velocity of the current is greatly intensified, as the high precipitous banks confine the water within but a slightly increased width. At two points only is this velocity such that assisting lines are required by ascending steamers. The excessive current at these places is due to the narrowing of the channel by points projecting from the left bank. One of these is near the point marked C on the map and the other at the large projecting bluff opposite the point D farther down. At the upper place the removal of Rocks A and B and part of point C will permit steamers to ascend with the assistance of a line from Ringbolt Rock, without risk of damage by contact with sunken rocks. These rocks (A, B, and C) will require removing to the extent, it is estimated, of 4,500 cubic yards. This work will not be very expensive, as the rocks stand well above low water and with deep water to receive the débris all around.

It is estimated that the work will cost about $1.50 per cubic yard, which for the 4,500 yards will aggregate $6,750.

At the lower place, by the point D, the ruggedness of the left bank and its very irregular contour induce at high water strong currents, counter currents, eddies, and whirls. The ruggedness of this bank precludes the possibility of safely leading assisting lines ahead; ascending steamers, for these reasons, avoid that bank at high water and ascend near the right bank. Here, however, they are subject to danger of damage by violent contact with the large masses of rock irregularly distributed over the bank, and find great difficulty in getting their assisting lines ahead. The remedy proposed here is to smooth down the bank by blasting of the large projecting rocks and filling in the depressions, thus roughly riprapping the surface, and to make one or more roughly paved runways for use in taking the lines ahead to a ringbolt placed at the upper end. The length of bank to be thus improved is estimated at 800 feet. Considering the present and prospective traffic on the river, this is, in my opinion, the best solution of the problem at this place. The cost of this work is estimated as follows: Breaking up and removing 800 cubic yards of rock, at $1.50, $1,200.

Entiat Rapids.—At Entiat Rapids the river is navigable at medium and higher stages of water; but these rapids offer obstacles at the lower stages; the shoalness of the water in the west and middle channels barring passage there, and the very rapid current and excessive fall for a short distance in the east channel necessitating a resort to lining by ascending steamers. The east channel offers at present the only low-water passage, and this only with the use of assisting lines at the lower one of the two chutes in the rapid. The upper chute is passed without lining. The head of the lower chute is immediately below an abrupt bend in the channel. It is at the head of this chute that the swiftest current occurs and where the assistance from the shore line is most required. It would be desirable, if practicable, to ascend near the left bank. The river, however, next to the left bank and for nearly one-half of its width is shoal and rocky; the navigable part of the river lying close to the right bank. This shoal and rocky part precludes the possibility of leading lines ahead to a suitable fastening above. To overcome this difficulty it is suggested that a suitably constructed boom be attached to the lower end of the small gravel bar island P; the boom to be secured by chain attached to a deadman placed on the gravel bar above at the point marked A. This

boom is designed to float about in the position marked on the tracing herewith, its lower end about 600 feet below the island P. A solid round post to be placed at the point B, and a deadman to make a line fast at the point marked C. The method of using the construction would be the following: A steamer would go up and make fast to a ringbolt at the lower end of the boom; men would then get out on the boom and take a line ahead on it to the island P, passing to the right of post B, and making it fast at C. The steamer would then cast loose, and with the assistance of the line would steam up toward B. On arriving opposite the end of the island P, the steamer would hold well out, taking the line away from B, rounding the point, and getting an oblique pull on C, until the quiet water between islands P and N is eached, when the line would be taken on board and the steamer go on without assistance. The course of the boat would be about as shown by the dotted line. The boom is designed to be 4 feet wide, and made of three pieces of timber, 12 by 16 inches, bolted together. For flexibility it will be made in lengths of about 100 feet, with two lengths of 50 feet each at its upper end. It would be fastened with a sufficiently long chain to allow for the difference between high and low water, and it is believed that its position below the islands M and P will secure it against damage during high water in the river. The boom would be required only at the lower stages of water in the river. It would be to the interest of the steamboat people to look well after the safety of the boom, and this they agree to do. It would be anchored with a deadman and chain at its lower end, so that if it broke away above it would still be caught and remain in the vicinity.

The estimated cost of the boom and its fastenings is as follows:

Five sections, each 102 feet 8 inches long, at $121 per section	$605
Two sections, each 51 feet 4 inches long, at $74 per section	148
Deadman and chain at head of boom	120
Deadman and chain at foot of boom	40
Two mooring posts, at $12	24
Towage of boom to destination and putting it in place	100
Total	1,037

A drawing of the boom is shown on the map of Entiat Rapids.

Rocky Reach.—At Rocky Reach the navigable channel lies close to the left bank. Lining is not necessary here. To avoid the strong current ascending steamers hug the bank closely, while descending steamers at low water seek that bank to avoid a few bowlders and rock points which obstruct the channel. The plan of improvement here is the smoothing down of the left bank at point K, by breaking down the large bowlders and rocks and filling in the depressions with the débris, and by removing the sunken rocks which impinge on the channel. It is estimated that about 1,000 cubic yards of rock, most of which is exposed at low water, is to be removed from this stretch of the river. This, it is estimated, will cost $3 per cubic yard on an average, or $3,000 in all.

Besides these three main points where navigation is obstructed, there are eight points where obstructions exist in the form of gravel bars, upon which the depth is from 6 to 8 feet at low water and the velocity from 5 to 8 miles per hour. These bars contain numbers of small bowlders. The bars are difficult and dangerous both going up and coming down at very low water, which is the period of greatest need of navigation on the river.

It is believed that these bars can be materially improved by picking up the larger bowlders with grapplers, and by hauling a heavy drag

over the bars, and thus stirring up the material, and causing it to reach the deep water below. The cost of constructing the requisite drag, procuring the plant necessary to operate it, and for the work itself, is estimated at $8,000.

The total estimated cost of the work recommended is as follows:

Rock removal at Methow Rapids	$7,950
Boom at Entiat Rapids	1,037
Rock removal at Rocky Reach	3,000
Work on 8 minor gravel bars	8,000
Total	19,987

The river and harbor act of August 17, 1894, contains an item allowing the expenditure of the balance of the appropriation made for the improvement of the river between Rock Island and Priest Rapids, in improving this stretch of the river from Rock Island to Foster Creek Rapids, which latter is just above the mouth of the Okanogan River.

The amount thus rendered available was $8,005.20. Taking this from the total estimate leaves $11,981.80 as the amount required to carry the project to completion.

The report of Mr. C. F. B. Haskell, assistant engineer, is herewith.

Very respectfully, your obedient servant,

THOMAS W. SYMONS,
Captain, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., May 31, 1895.

Respectfully forwarded. Recommended.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

REPORT OF MR. C. F. B. HASKELL, ASSISTANT ENGINEER.

CAPTAIN: I have the honor to submit the following report of the survey of the Columbia River, between the mouth of the Okanogan River and Rock Island, made under instructions contained in your letter of September 14, 1894.

The objects of this survey, as defined in your letter of instructions, were:

First. To secure data for a chart and profile of the river.

Second. To determine the nature and the extent of the obstructions to the free navigation of the river.

Third. To gather such information as would enable your office to decide upon the best methods of improving the river, and the cost of the same, with especial reference to the immediate expenditure of the appropriation now available for work on the upper Columbia.

The camp outfit for this survey was shipped from Portland and the supplies from Spokane. Two skiffs were purchased, and stadia and gauge rods were manufactured in Wenatchee, Wash.

Everything for the expedition having been assembled at Wenatchee, I left there on the steamer *City of Ellensburg* October 1, 1894, for the mouth of the Okanogan River with the outfit and nine men. We reached the Okanogan the night of October 2. The next day we purchased cedar logs from an Indian on the Colville Indian Reservation and began building a raft. This raft was 40 feet long by 20 feet wide. The body of the raft was composed of cedar logs. It had a deck of lumber about 2 feet above the water, and was handled by means of two sweeps, one at each end.

It was in every way entirely satisfactory. We pitched our tents on the raft, and until the completion of the survey we lived entirely on the raft.

The field work of the survey was completed December 23, 1894.

The length of the river surveyed was 80½ miles. The cost of the field work of this survey, together with all incidental expenses, including the cost of the new outfit purchased and now on hand, was $2,100.

We began our survey at the southwest corner of section 20, township 30 north, range 25 east, Willamette meridian.

We ran a continuous angle line down the left bank of the Columbia, and connected our survey with the Government land surveys whenever practicable.

We obtained a due north and south line by observations on Polaris.

All angles were read to minutes with a Buff and Berger transit, and were verified by magnetic bearing.

All distances were measured with stadia, targets being used on the stadia rods.

On the main line all distances were read twice, forward and back, and the average of the two readings was taken.

Points on the right bank, islands, and exposed rocks in the river were located by single stadia readings.

The shore line between stadia stations was sketched.

A continuous line of levels was run with a Y level, beginning at bench mark No. 28, established by William Cuthbert.

The elevation of the water was taken at every stadia station, also at the head and foot of all rapids.

Elevations of high-water marks were taken as often as thought necessary.

Soundings were taken every half minute, and in shoal water every fifteen seconds, from a boat drifting with the current. This boat was located every minute by observations with two transits.

Eleven bench marks were established at points where it was thought they would be most useful in the future.

The velocity of the currents was determined by means of floats.

We believe that by these methods we have secured all necessary accuracy and detail.

A map and profile have been prepared to accompany this report; the map drawn to a scale of 2,000 feet to 1 inch, the profile drawn to a scale of 4,000 feet to 1 inch horizontally, and 30 feet to 1 inch vertically.

The map shows the depth of water, the location of all bars, islands, rocks that are bare at low water, and as many submerged rocks as we could locate, together with all bench marks, town sites, highways, and Government land lines adjacent to the river.

Enlarged plats, on the scale of 400 feet to the inch, have been made of Rocky Beach, Entiat, and Methow rapids, three places where navigation is seriously obstructed.

The profile shows the bottom of the river, the elevation and slope of the surface of the water at both high and low water.

A gauge was established at Wenatchee, readings being taken three times a day.

All soundings and levels of water shown on the map and profile have been reduced to the lowest stage of water observed during the survey. This is equivalent to a reading of 7 feet on the gauge established by Government Weather Bureau at Wenatchee, and is supposed to be about 4 feet above low water.

The Columbia, between the mouth of the Okanogan and Rock Island, flows through a deep valley. On the east lies the Big Bend country, a plateau rising in from 2 to 6 miles to a general elevation of 2,000 feet above the river. The Big Bend is preeminently a dry country, no stream entering the Columbia from the east within the limits of this survey. Some of the way the bluffs are close to the river, while at other places they are farther back, leaving considerable areas of good farming land near the river.

The principal places where the valley widens out are at the mouth of the Okanogan River, Troy, Orondo, and Wenatchee. At each of these places there are several thousand acres of arable land.

Wagon roads connect the Big Bend country with the river at Virginia City, Central Ferry, Chelan Falls, Knapps Ferry, Troy, Orondo, and Wenatchee.

Large quantities of grain and other farm products are brought over these roads to be shipped by boat to Wenatchee, where connection is made with the Great Northern Railway.

The best settled and most productive part of the Big Bend country is a belt a few miles wide lying near the Columbia River.

On the west side of the river are the foothills of the Cascade Mountains. This country is much rougher than the Big Bend country and contains very little arable land, except close to the Columbia and in the valleys of the tributary streams. There are five streams entering the Columbia from the west in the limits of this

survey—the Okanogan, Methow, Chelan, Entiat, and Wenachee. The divides between these streams are spurs of the main range of the Cascades, and are often higher and more rugged than the main range itself. The valleys of these streams afford the only practicable means of reaching the interior, and they enable mining and lumbering operations to be carried on far back toward the main range of the Cascades.

Nearly all the land in the Columbia Valley and in the lower part of the tributary valleys, which can be irrigated, is good farming land. This region is especially adapted to growing nearly all kinds of fruits. The trees and vines produce abundantly, and the fruit is of the finest flavor.

These valleys already furnish a considerable part of the business done on the river.

The length of the Okanogan Valley, from the Columbia to the boundary, is about 70 miles. Tributary to this valley are the towns of Oro, Loomis, Conconully, and Ruby City. It contains some very rich mines in addition to large areas of fine farming land.

Government land surveys have been extended over a considerable part of this valley during the past season.

The legislature of Washington has passed the necessary laws to assure the selection and reclamation of 1,000,000 acres of arid land given to the State by the last Congress. There is in this valley one of the largest tracts of arid land susceptible to irrigation in the State, and it is expected that the State's selection in this vicinity will materially aid in the development of the valley. This, in connection with the opening up for settlement of the north half of the Colville Indian Reservation, which it is expected will take place in the near future, will still further increase the demand for better transportation facilities.

The valley of the Okanogan, which has perhaps greater possibilities of future development than all the rest of the country tributary to the upper Columbia, will not receive the greatest possible benefit from the improvement of the Columbia, unless the Okanogan River is also made navigable.

The steamer *Ellensburg* has navigated the Okanogan River during high water for several seasons, bringing out several hundred tons of ore.

The Methow Valley is narrow near the Columbia; but a few miles back it widens out and contains some good land. If the Methow country ever amounts to anything, however, it will be as a mining and not as an agricultural country. Some very rich gold prospects have been discovered on tributaries of the Methow, and many expect that this valley will eventually contain one of the best mining camps in the State.

The Chelan River is about 3 miles long and connects Lake Chelan with the Columbia River. It flows through a wild rocky gorge, having a fall in the 3 miles of something over 300 feet.

Lake Chelan is about 70 miles long. At the lower end of the lake are the towns of Chelan and Lakeside. Near the head of the lake is situated the famous Horseshoe Basin mining region, containing some very rich silver properties.

Large quantities of logs are brought down from the upper end of the lake to be sawed by the mills at Lakeside.

The Entiat Valley is narrow and contains but little good land. Considerable quantities of logs are annually run down the river during high water, to be cut by the mill near the mouth of the stream.

The business of the Wenatchee Valley is accommodated by the Great Northern Railway. The railway company has recently built a track from their yard at Wenatchee to the steamboat landing, to facilitate the transfer of freight between the boats and the railroad.

There are twenty-five rapids in the Columbia River between the Okanogan River and Wenatchee, which cause more or less trouble to navigation. For convenience they are numbered consecutively, beginning at the Okanogan. They may also be divided into two general classes:

First. Those which only exist or which become much worse during high water.

Second. Those which are troublesome during low water and which partially or wholly disappear during high water.

This second class may be again divided into two classes, distinguished by the conditions which cause them:

Class A.—Those caused by the narrowing of the channel. At these places the water is swift and deep.

Class B.—Those caused by bars or ledges across the channel. At these places the water is swift and shoal.

Of the first general division there is only one example in that part of the river under consideration, namely, No. 2 or Methow Rapids. At this place the river is narrow and deep. During high water the river has no chance to spread out, and consequently the water is dammed back and rushes through the gorge with great velocity. At low water the fall of the river at this place for one-half mile is 1 foot, and boats have no serious difficulty in passing the rapids. During high water

of last year the fall in the same half mile was 5 feet. The south shore at this place is covered with large bowlders. The north shore is a nearly continuous bluff for a mile, from which several rock points extend well out into the river, making the passage of the rapids during high water very difficult and dangerous.

For nearly half a mile below Ringbolt Rock there is an eddy along the north shore, caused partly by Ringbolt Rock and partly by the ledge extending into the river opposite point D.

In high water, boats ascending have to line for about 800 feet around point D. They then steam up to a little above Smith's house and cross over to the north shore, to take advantage of this eddy. If it were not for rocks A and B and point C, it would be easy to steam up to Ringbolt Rock. From Ringbolt Rock it is customary to cross over into the eddy along the south shore, just above where the river narrows. At certain stages of the water the point C and rocks A and B force the boat out of the eddy into the swift water, making it necessary to use a line, and greatly increasing the difficulty and danger.

It is recommended that on the north shore the rocks A and B and the point C be removed to such an elevation that boats can go over them in the higher stages of water, thus following closely the shore and keeping out of the swift water.

It is further recommended that on the south shore the large bowlders on the point opposite Ringbolt Rock be broken up, and that point D be improved by breaking up the large bowlders which now seriously interfere with laying a line, and that suitable fastenings for a line be put in.

The Entiat Rapids, No. 18, come under the head of Class B. They extend over about 1 mile. At high water the fall in this mile is 5 feet, and boats can steam the rapids without much difficulty. At low water the fall in this mile is 10 feet, most of it occurring in about one-half mile; the velocity of the current there reaches 10¾ miles per hour. In low water these are the worst rapids between Wenatchee and the Okanogan, and can not be passed by boats now on the river without the use of lines.

The bed of the river is composed of small bowlders. There is nothing to indicate that there is any bed rock extending across the river at this place.

The river here is quite wide and at low water is divided by gravel islands into three channels, east, middle, and west.

The west channel is shorter and contains less water than the east channel, but is longer and contains more water than the middle channel. It is used in certain stages of the water by boats going up the river, on account of their being able to take advantage of several eddies. In low water the boats, in descending, always take the east channel. The middle channel is not used at all in low water.

On the west side of the west channel are two rock points against which the current strikes with great force. Near the lower end of this channel are three rock islands, bare at low water, nearly in the middle of the channel.

The east channel is the longest of the three, and at low water contains much more water than both of the other channels. The fall is more concentrated in this channel than in the others, the last 1,000 feet having a fall of 6 feet. I do not believe that it is practicable, nor indeed desirable, to change the slope of the river at this place.

The best part of the river to navigate between Rock Island and the Okanogan, is the 10 miles immediately above the Entiat Rapids. To distribute the slope of the rapids over this part of the river would result in injuring, to a greater or less extent, this piece of good river without improving the rapids sufficiently to obviate the necessity for lining. Moreover, to cut through the bar causing these rapids so as to materially reduce the slope of the water, would be a very expensive undertaking, in my opinion, not justified by the amount of business on the river.

It is recommended that the east channel only be improved, and that this be improved by removing all the dangerous submerged bowlders possible, and by putting in a boom of 12-inch square timbers 4 feet wide to assist in laying a line and to act as a fender to keep the boat from striking the shore.

It is suggested that the proper and only safe place for this boom is along the south shore of island M; that the upper end of it should be anchored on the lower end of the small island between islands M and N, and that it extend down from the lower end of this small island about 600 feet. It is also suggested that suitable fastenings for lining be put in on this island.

When this is done the passage of these rapids ought not to take, under ordinary circumstances, more than thirty minutes.

At Rocky Reach, No. 22, there is a reef partly bare at low water, extending from the west bank nearly across the river, leaving a narrow channel near the east shore. There is in this channel at least one large submerged rock, marked J on the plat. There are also many large bowlders on the point K which still further reduce the available steamboat channel until it is quite narrow. It is quite difficult for loaded boats going downstream in low water to avoid both the rock J and the rocky point K.

It is recommended that the rock J be removed and that the large bowlders on the points K and L be broken up.

There are said to be other submerged rocks at this place which we could not find. If any of these are found and are dangerous to navigation, it is recommended that they be removed.

In the rapids of Class A may be included the numbers 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 21, 23, and 24, having a depth of water ranging from 8 feet to 30 feet, and with a velocity of current ranging from 4.5 to 7.6 miles per hour.

These rapids add materially to the expense, difficulty, and danger of navigation, but as the boats now on the river can steam them without serious difficulty, I do not think there is now, or is likely to be in the future, sufficient commerce to warrant attempting to improve them.

Rapids of Class B include numbers 1, 3, 4, 6, 16, 19, 20, and 25, having a depth of water varying from 6 feet to 8 feet and with a velocity of current ranging from 5.3 to 7.8 miles per hour.

These rapids are a more serious obstruction to navigation than those of Class A. In addition to the difficulty of passing them going up river there is also danger of boats grounding on the down trip. All of these bars contain more or less small bowlders, and such an accident would be liable to seriously damage the boat, besides causing delay and expense in getting off.

At most of these rapids there is a greater or less extent of comparatively still water above them, indicating that the bar acts as a submerged dam. If the top of this bar or dam could be lowered it would tend to distribute the fall, which is now concentrated at the bar over much of the river, diminishing the slope of the water and consequently the velocity of the current. The current at these places is quite swift, and if the material composing the bar is loosened up the water will probably remove much of it.

It is suggested that a heavy drag, suitable for stirring up the material composing the bottom of the river, be hauled over the bars at some of these places and the effect carefully noted. If this kind of treatment will materially improve these rapids it is probably the cheapest way in which it can be done.

As the part of the river between Wenatchee and Rock Island can be navigated, if necessary, without serious difficulty, and as no commerce whatever exists below Wenatchee, it is recommended that no attempt be made to improve this part of the river.

Accompanying this report are three schedules, as follows:

First. A list of bench marks established, with descriptions, elevations, etc.

Second. A table of distances showing the distance of prominent places from the International Boundary, from the mouth of the Columbia River, and also from Wenatchee, the initial point of steamboat navigation.

Third. A list of obstructions to navigation in the river between Okanogan River and Wenatchee, with location, description, and estimate of number of cubic yards of rock to be removed.

Very respectfully, your obedient servant,

C. F. B. HASKELL.

Capt. T. W. SYMONS,
Corps of Engineers, U. S. A.

List of bench marks.

Bench mark.	Description.	Elevation.
		Feet.
No. 28	At intersection of Main street and Washington avenue, Port Columbia, Wash. On a cedar post 6 inches in diameter, 8 inches above ground, marked U. S. B. M. with tacks. Established by William Cuthbert.	817.21
No. 29	At the northwest corner of intersection of Okanogan and Broadway streets, Virginia City, Wash. At southeast corner of Pioneer Store, on granite rock 6 by 6 by 24 inches, set 20 inches in the ground.	789.12
No 30	On east or lefthand bank of the Columbia, about 1,000 feet below the mouth of the Methow. On the ring bolt set in the top of Ringbolt Rock.	776.03
No. 31	At meander corner on the left bank of the Columbia on south side of sec. 6, T. 28 N., R. 24 E., Willamette meridian. On nail in root of bearing tree 14 feet north of corner.	759.63
No. 32	At southwest corner of intersection of Chelan avenue and First street, Chelan Falls, Wash., at northeast corner of hotel. On granite rock 6 by 6 by 24 inches, set 20 inches in the ground.	763.10
No. 33	At Downing Rapids, 3 miles below Chelan Falls, on the left of main channel. On the top of the highest rock in the rapids.	735.83
No. 34	At northeast corner of intersection of Kellogg street and Navarre avenue, Troy, Wash. On rock 6 by 8 by 24 inches, set 20 inches in the ground.	726.23
No 35	At northeast corner of intersection of Riverside avenue and First street, Orondo, Wash. On granite rock 6 by 8 by 24 inches, set 20 inches in the ground.	708.36
No. 36	At limekiln, 6 miles above Wenatchee. On bottom of lower brick inside of arch, northeast corner on right-hand side, when facing arch.	684.51
No 37	Near corner of Wenatchee and Orondo avenues, Wenatchee, Wash. On left-hand corner of lower step of Columbia Valley Bank building.	699.12
No. 38	At Great Northern Railway Bridge. On northeast corner of top of south pier on west bank of river.	642.31
No. 39	At head of Rock Island. On left bank at north end of cut on Great Northern Railway, on nail in telegraph pole.	653.72

ELEVATIONS.

Elevation of top rail at Wenatchee depot, Great Northern Railway, by river levels	673.82
By railroad levels above mean high tide, Seattle, Wash	642.00
By railroad levels above mean low tide, Seattle, Wash	655.50
By railroad levels from Atlantic coast	634.75
High water at Wenatchee, 1894	674.50
Elevation of zero mark of Weather Bureau gauge at Wenatchee, Wash	614.70
High water at Great Northern Railway Bridge, 1894	646.50
Top of rail at Great Northern Railway Bridge	696.68

Distance table.

Name of place.	From international boundary.	From mouth of Columbia River.	From Wenatchee, the initial point of steamboat navigation.	Name of place.	From international boundary.	From mouth of Columbia River.	From Wenatchee, the initial point of steamboat navigation.
	Miles.	*Miles.*	*Miles.*		*Miles.*	*Miles.*	*Miles.*
Okanogan River	214	546	68.3	Entiat Landing	264	496	18.3
Virginia City (town)	218	542	64.3	Entiat River	265	495	17.3
Central Ferry	220.5	539.5	61.8	Orondo (town)	266	494	16.3
Methow River	224	536	58.3	Haleys Ford	268	492	14.3
Parkers Landing	228	532	54.3	Koehlers Landing	272.3	487.7	10
Chelan Landing	243.6	516.4	38.7	Rocky Reach	273.6	486.4	8.7
Chelan River	244.6	515.4	37.7	Wenatchee River	280	480	2.3
Chelan Falls (town)	245	515	37.3	Wenatchee (town)	282.3	477.7	.....
Downing Rapids	247	513	35.3	Great Northern Railway Bridge (below)	291.4	468.6	9.1
Knapps Ferry	253.7	506.3	28.6	Rock Island (below)	294.5	465.5	12.2
Troy (town)	255.7	504.3	26.6				
Ribbon Bluff Landing	258.8	501.2	23.5				

INDEX MAP of UPPER COLUMBIA RIVER SURVEY, Sheets, Nos 1 to 12.

To accompany Report of Capt T.W. Symons Corps of Engineers, dated May, 22nd 1895

SCALE miles 10 5 0 10 20 miles

NOTE: Sheets Nos 1 to 9 were submitted with Report of Capt T.W. Symons, dated March 15th 1893.

BRITISH COLUMBIA

International Boundary Line

120° 119° 118° 49° 48°

SHEET, 1. SHEET, 2. SHEET, 3. SHEET, 4. SHEET, 5. SHEET, 6. SHEET, 7. SHEET, 8. SHEET, 9. SHEET, 10. SHEET, 11. SHEET, 12.

Osoyoos Lake, Similkameen River, Tonasket Cr., Kettle River, Bonaparte R., Concomully, Conconully Cr., Okanogan River, Twitsp River, Alma, Omack Lake, Ophir, Methow River, Virginia City, Columbia River, Foster Creek Rapids, Halfchen Rock, Head of Long Rapid, Parson Rapid, Mathin Rapid, Nespilem River, Equilibrium Rapid, Central Ferry, Methow Rapids, Westfield, Foster Cr., Vaughan Rap, Cariota Bend, Rapids Nos 3 & 4, Rapids Nos 4 & 5, Rapids Nos 7 & 8, Rapid No 9, Chelan, Chelan Falls, Downing's Rapid, Rapids Nos 16 & 17, Troy, Grapp's Ferry, Rapids Nos 14 & 15, Entiat River, Entiat Rapids, Orondo, Waterville, Douglas, Hunt's Rapid, Badger, Rapid No 21, Rocky Reach Rapid, Rapid No 23, Wenatchee River, Wenatchee Rapids, Wenatchee, Moses Coulee, Rock Island Rapids, Cabinet Rapids, Moses Lake, Rattlesnake Rapid, Coulee Bend, Ne-ah-kwa Creek, Mammoth Spring, Hesseltine, Sherman, Lincoln, Vorhees, St Andrews, Coulee City, Hartline, Almira, Goyan, Wilbur, Benson, Viola, Brents, Hell Gate, Whitestone Rock, Castle Cove, Mitre Rock, Spokane Rapids, Ft Spokane, Big Bend, Hawk Cr., Egypt, Spokane River, Deer Park, Walker's Prairie, Chattaroy, Crescent, Greenwood, Larene, Mondovi, Davenport, Deep Cr. Falls, Medical Lake, Cheney, Harrington, Earl, Lake Cr., Crab Lake, Crab Cr., Woodson, Sylvan L., Sprague, Harriston, Rosalia, Spangle, Marshall, Loon L., Elbow Bend, Rogers Bar, Sare Poil Reservation, Inserumkin Creek, Entiat Rapids, Hunt's Rapid, Sheep Creek, Little Dalles, 4 Mile Rapid, Sheep Creek Bend, 2 Mile Bar, Ringstones Rapid, Marcus, Kettle Falls, Harvey, Rickey's Ldg., Drift wood Rocks, Colville, Colville River, Arden, Clarke's Fork or Pend d Oreille River, Calispel Lake, Chewelah, Francais Bar, Charley Gifford's Rapid, Turtle Rapid, Encha-lay-em Cr., Sin-poil-hu Cr., Grand Rapids, Harawip L., Kettle River, Hettle River, Simil-ka-meen River, Tonasket Cr., Osoyoos Lake, Omack Lake, Alma, Concomully, Conconully Cr., Twitsp River, Okanogan River, Ophir, Virginia City, Methow River, Methow Rapids, Chelan, Chelan Falls, Entiat River, Wenatchee River, Wenatchee Rapids, Wenatchee, Moses Coulee, Rock Island Rapids, Cabinet Rapids, Moses Lake, Grand Coulee, Coulee City, Hartline, St Andrews, Almira, Goyan, Wilbur, Benson, Viola, Davenport, Deep Cr. Falls, Medical Lake, Cheney, Harrington, Earl, Lake Cr., Crab Lake, Crab Cr., Woodson, Sylvan L., Sprague, Harriston, Rosalia, Spangle, Marshall, Spokane, Larene, Mondovi, Crescent, Greenwood, Chattaroy, Deer Park, Walker's Prairie, Loon L., Elbow Bend, Rogers Bar, Sare Poil Reservation, Inserumkin Creek, Entiat Rapids, Hunt's Rapid, Sheep Creek, Little Dalles, 4 Mile Rapid, Sheep Creek Bend, 2 Mile Bar, Ringstones Rapid, Marcus, Kettle Falls, Harvey, Rickey's Ldg., Drift wood Rocks, Colville, Colville River, Arden, Clarke's Fork or Pend d Oreille River, Calispel Lake, Chewelah, Francais Bar, Charley Gifford's Rapid, Turtle Rapid, Encha-lay-em Cr., Sin-poil-hu Cr., Grand Rapids, Harawip L., Kettle River, Hettle River, Simil-ka-meen River, Tonasket Cr., Osoyoos Lake

COLVILLE INDIAN RESERVATION

SPOKANE IND. RES.

GREAT NORTHERN RAILWAY

WASHINGTON CENTRAL R.R.

NORTHERN PACIFIC R.R.

SPOKANE & PALOUSE R.R.

GREAT NORTHERN RY.

N.P.R.R.

U.P.R.R.

SPOKANE & NORTHERN R.R.

GRAND COULEE

PLAIN OF THE COLUMBIA RIVER

Eng 54 1

SHEET 15

SHEET 11

SHEET 10

SHEET 9

SHEET 8

SHEET 7

SHEET 6

SHEET 5

SHEET 4

SHEET 3

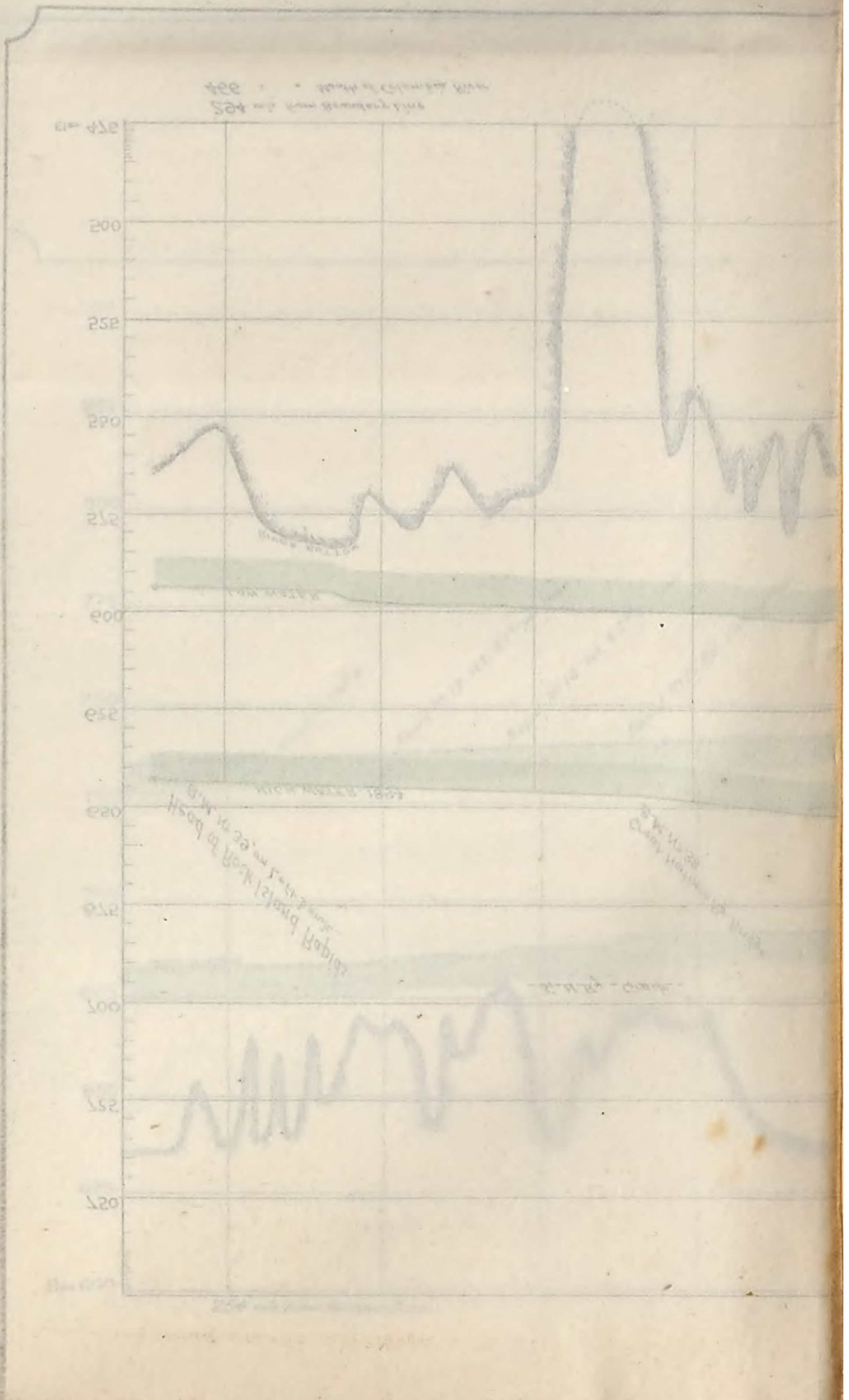
SHEET 2

SHEET 1

CORK

North line of T° 27 N. R 23 E.

5


200
250
300
350
400
450
500
550
600

List of obstructions to navigation in the Columbia River between Wenatchee and Virginia City, Wash.

Name of obstruction.	Number of rapid.	Class of rapid.	Distance from international boundary.	Depth of water.	Velocity of current, per hour.	Rock to be removed.		Remarks.
						Submerged.	Dry.	
			Miles.	*Feet*	*Miles.*	*Cu. yds.*	*Cu. yds.*	
Rock	....	.....	223.4	.....	.....	12	.....	Should be removed.
Rapids	1	B	224	7	7.7	.....	.....	See report.
Methow Rapids	2	No. 1	224.5	50	5.5	.....	.....	Do.
Rock A	....	.....	.....	.....	.....	.....	148	All included in the improvement of the Methow Rapids.
Rock B	....	.....	.....	.....	.....	.....	889	
Point C	....	.....	.....	.....	.....	.....	3,500	
Point D	....	.....	.....	.....	.....	.....	800	
Rapids	3	B	228.6	7	6.5	.....	.....	See report.
Do	4	B	230.9	6	5.7	.....	.....	Do.
Do	5	A	232.9	13	5.7	.....	.....	Nothing recommended.
Do	6	B	233.9	8	5.3	.....	.....	See report.
Do	7	A	235	13	5	.....	.....	Nothing recommended.
Do	8	A	237.1	16	5.7	.....	.....	Do.
Do	9	A	239.8	11	7.6	.....	.....	Do.
Do	10	A	241	12	7.6	.....	.....	Do.
Do	11	A	242.3	17	7.4	.....	.....	Do.
Chelan Rapids	12	A	244.4	22	6	.....	.....	Do.
Chelan Rock	....	.....	244.8	.....	.....	89	.....	To be removed.
Downing Rapids	13	A	247	8	6.3	.....	.....	Nothing recommended.
Rapids	14	A	249.5	17	5	.....	.....	Do.
Do	15	A	251.5	17	6.8	.....	.....	Do.
Do	16	B	252.3	6	6.5	.....	.....	See report.
Do	17	A	253	12	5.1	.....	.....	Nothing recommended.
Rock	....	.....	253.3	.....	.....	.....	322	At east shore.
Vaughn Rock	....	.....	261.2	.....	.....	123	.....	Should be removed.
Entiat Landing	....	.....	264	.....	.....	295	550	Do.
Entiat Rapids	18	B	265	9	10.7	50	.....	Do.
Orondo Rock	....	.....	266.1	.....	.....	250	.....	Do.
Hunts Rapids	19	B	267	7	6.5	.....	.....	See report.
Haleys Ford Rapids.	20	B	268	7	7	.....	.....	Do.
Rapids	21	A	271.3	30	4.5	.....	.....	Nothing recommended.
Rocky Reach	22	A	273.6	27	4.5	248	300	See report.
Rapids	23	A	275	15	6	.....	.....	Nothing recommended.
Wenatchee River Rapids.	24	A	280	14	6.8	.....	.....	Do.
Wenatchee Rapids	25	B	281.2	7	6	.....	.....	See report.
Total	....	.....	.....	.....	.....	1,067	6,509	

T T 40.

ESTABLISHMENT OF HARBOR LINES IN PUGET SOUND AT SEATTLE AND BALLARD, WASHINGTON.

OFFICE BOARD OF TIDE LAND APPRAISERS FOR KING COUNTY,
Seattle, Wash., September 13, 1894.

SIR: Under the law creating and empowering this board, it is important—almost indispensable, in fact—that the harbor lines fronting the cities of Seattle and Ballard be established at once. The State land commission has done this work as far as the State can do it, and to make the lines established final and complete now requires only the approval of your Department. We trust that you will take the steps necessary to give the State lines the desired approval, if in your judgment, after due examination, they are found to be wisely and properly laid.

Very respectfully,

FRED. W. SPARLING,
Chairman of the Board.

Hon. DANIEL S. LAMONT,
Secretary, War Department.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
October 13, 1894.

Respectfully referred to Col. G. H. Mendell, Corps of Engineers, for report.

Colonel Mendell is authorized to call on Capt. T. W. Symons, Corps of Engineers, for any information or assistance desired.

To be returned.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Third indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., October 30, 1894.

Respectfully returned to the Chief of Engineers, U. S. Army, with report.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

[Fourth indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 14, 1894.

Respectfully returned to the Secretary of War.

Application having been made by the authorities of King County, Wash., for the establishment of harbor lines at Seattle and Ballard, and for the approval by the Secretary of War of certain lines adopted by the board of land commissioners of that State, the subject was referred to Col. George H. Mendell, Corps of Engineers, who has given the same careful consideration and submits the accompanying report of the 30th ultimo, to which attention is respectfully invited.

The harbor lines recommended by Colonel Mendell are referred to in his report as being indicated on the drawings by red and yellow lines. (See blue prints* marked A and B.)

But to avoid possible misunderstanding in the future I have had these different colored lines changed on the tracings* herewith to *full black lines*, and I recommend that the full black lines shown on the tracings of Seattle and Ballard harbors be established as pierhead lines for those harbors and adjacent waterways.

The tracings have been prepared for the approval of the Secretary of War.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

[Fifth indorsement.]

WAR DEPARTMENT, *November 17, 1894.*

Respectfully returned to the Chief of Engineers with the harbor lines approved as recommended.

JOSEPH B. DOE,
Acting Secretary of War.

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* Omitted.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., October 30, 1894.

GENERAL: As directed by Department indorsement * * * of October 13, 1894, I make report in the matter of harbor lines at Seattle and at Ballard, Wash.

The lines shown in red on the two accompanying blue prints* are understood to have been proposed and adopted by a board of commissioners constituted under the constitution and laws of the State of Washington. These lines, in whole or in part, were submitted to a Board of Engineer Officers, appointed by the War Department, under instructions to make recommendations in regard to them to the War Department, in order that harbor lines might be established as provided in various river and harbor acts. The Board of Engineer Officers finding that the question of ownership of adjoining submerged lands was in litigation declined at the time to make recommendations. It is now understood that the courts have settled the issues in question in favor of the State, and, so far as known, there is now no reason why the War Department may not now proceed to establish lines as provided in the river and harbor acts.

The undersigned was a member of the Board of Engineer Officers herein referred to. Captain Symons was also a member. We have consulted as to this matter, and are in agreement to report that the lines at Seattle and Ballard, so far as represented in red on these maps, are suitable for adoption, with the reservation that no bulkhead lines need be established.

Along the whole Sound front, extending from the outlet of Salmon Bay to the southern boundry of the map, the lines are shown double, an outer and an inner line, parallel with an interval of 300 feet; except that in the southern part over the tide lands the interval is 600 feet. Through these tide lands there are laid out two side channels or waterways, 1,000 feet wide and 2,800 feet apart, which extend to the eastward as a whole, or subdivided to the limit of jurisdiction of the State, ending near the outlet of the Duwamish River, which is accustomed to diffuse itself over the flats.

Attention is asked to the yellow lines drawn in these side channels, and also in definition of the river. The last-named lines are outside of the jurisdiction of the State board, and are proposed by Captain Symons and myself as needful to complete the system. Reference to this point is made in Mr. Sparling's letter of October 2.

The yellow lines in the two 1,000-foot waterways are proposed for pierhead lines.

It is recommended that the War Department establish pierhead lines along the red lines shown on the map of Ballard Harbor, except that where two parallel lines are in red the outer only is to be established; that along the Seattle water front the outer red line be established, and in the waterways the yellow lines be established—that the yellow lines defining the Duwamish River be established—and that the red lines connecting the Duwamish River yellow lines with the waterways be established, and wherever there is a single red line it is to be established as a pierhead line.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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* Omitted.

DESCRIPTION OF HARBOR LINES AT SEATTLE, WASHINGTON.

For the inner limit of the reserved area.—Begin at a point 3,834.99 feet south and 3,637.90 feet east of the United States Coast Survey signal at Duwamish Head, in West Seattle, which point is 492.64 feet south and 1,796.25 feet east of the meander post corner to fractional secs. 11 and 12, T. 24 N., R. 3 E., on the north line between said sections, which meander post is near the Seattle Terminal and Railway Company's elevator in West Seattle; thence from said point run for said inner line of said reserved area north 65° 34′ 09″ east 1,477.44 feet; thence north 76° 42′ 13″ east 3,835.32 feet; thence north 58° 03′ 34″ east 1,738.19 feet; thence north 17° 14′ 15″ east 2,960.51 feet; thence north 19′ 07″ east 985.34 feet; thence north 15° 07′ 59″ west 891.11 feet; thence north 25° 21′ 48″ west 1,688.31 feet; thence north 48° 49′ 51″ west 2,453.09 feet; thence north 52° 56′ 53″ west 2,054.99 feet; thence north 42° 28′ 26″ west 1,907.37 feet; thence north 46° 10′ west 3,175.12 feet; thence north 61° 07′ 28″ west 872.09 feet; thence north 82° 19′ 41″ west 5,381.17 feet; thence north 56° 41′ 30″ west 5,732.34 feet; thence north 46° 32′ 06″ west 4,934.31 feet; thence north 26° 02′ 52″ west 5,783.70 feet; thence north 12° 48′ 15″ east 315 feet; thence north 75° 00′ 02″ east 1,768.12 feet; thence north 46° 03′ 16″ east 695 feet; thence north 29° 46′ 50″ east 1,972.10 feet; thence north 53° 52′ 35″ east 2,864.35 feet to a point which is 1,679.86 feet north and 588.29 feet east of the meander post to fractional secs. 9 and 10, T. 25 N., R. 3 E.

For the harbor line or outer line of reserved area.—Commence at the point heretofore described as the beginning point of the inner line of the reserved area; thence north 13° 38′ 49″ west 610.79 feet; thence north 65° 34′ 09″ east 1,421.64 feet; thence north 76° 42′ 13″ east 3,795.32 feet; thence north 58° 03′ 34″ east 1,875.35 feet; thence north 17° 14′ 15″ east 2,345.34 feet; thence north 19′ 07″ east 900.01 feet; thence north 15° 07′ 59″ west 823.56 feet; thence north 25° 21′ 48″ west 1,599.14 feet; thence north 48° 49′ 51″ west 2,380 feet; thence north 52° 56′ 53″ west 2,071.71 feet; thence north 42° 28′ 26″ west 1,925.20 feet; thence north 46° 10′ west 3,126.05 feet; thence north 61° 07′ 28″ west 776.55 feet; thence north 82° 19′ 41″ west 5,393.28 feet; thence north 56° 41′ 30″ west 5,827.26 feet; thence north 46° 32′ 06″ west 5,015.19 feet; thence north 26° 02′ 52″ west 5,943.72 feet; thence north 12° 48′ 15″ east 451.22 feet; thence north 64° 08′ 53″ east 538.93 feet; thence north 73° 21′ 32″ east 1,414.23 feet; thence north 46° 03′ 16″ east 576.39 feet; thence north 29° 46′ 50″ east 1,993.24 feet; thence north 53° 52′ 35″ east 2,841.24 feet, to a point identical with the initial point of the outer line of the harbor area reserved in front of the city of Ballard and which is 1,870.81 feet north and 341.04 feet east of the meander post corner to fractional secs. 9 and 10, T. 25 N., R. 3 E., and 764.27 feet north and 2,217.14 feet west of the United States Coast Survey signal at the south side of the entrance to Salmon Bay.

Smiths Cove waterway.—Beginning at a point on the outer harbor line 2,261.04 feet south of and 1,593.96 feet west of the meander post on the east side of Smiths Cove, corner to fractional secs. 24 and 25, T. 25 N., R. 3 E., which point is also 2,056.09 feet south of and 1,755.59 feet east of the Coast Survey signal on the west side of said Smiths Cove, thence run for the east side of said waterway north 08′ 22″ west to the meander line at head of Smiths Cove; and for the west side of said waterway commence at a point on the outer harbor line north 82° 19′ 41″ west 403.75 feet from the initial point above described of the east side of said waterway, thence running parallel to said east side and 400 feet distant therefrom north 08′ 22″ west to the meander line at head of Smiths Cove.

Said waterway is of a uniform width of 400 feet, and extends from the outer harbor line through the intervening tide lands to the head of Smiths Cove.

West waterway.—For west line of west waterway, commence at a point on the outer line of the harbor reserve, which is 2,538.84 feet south and 5,273.14 feet east from the United States Coast Survey signal at Duwamish Head in West Seattle; also being distant 803.50 feet north and 3,431.49 feet east from the meander corner to secs. 11 and 12, T. 24 N., R. 3 E., Willamette meridian, on the line running north between said sections, which corner is near the Seattle Terminal and Railway Company's elevator in West Seattle; thence from said point run for west line of west waterway south 5,025.84 feet; thence east 1,000 feet; thence south 42° 15′ east 2,750 feet; thence south 17° 56′ 45″ east 1,406.50 feet, to eastmost point on Government meander line of Island No. 3, in sec. 18, T. 24 N., R. 4 E., Willamette meridian.

For east line of said waterway, commence at a point on outer line of harbor reserve 2,302.52 feet south and 6,273.14 feet east from survey signal before mentioned, and 1,039.83 feet north and 4,431.49 feet east from meander post corner to secs. 11 and 12 above described, thence run for east line of west waterway south 4,667.25 feet; thence south 42° 15′ east 3,276.49 feet; thence south 17° 56′ 45″ east 752.56 feet, to point of intersection with west line of east waterway.

East waterway.—For east line of east waterway, commence at a point on outer line of harbor reserve 788.46 feet south and 10,073.14 feet east from previously described Coast Survey signal, which is also 2,553.89 feet north and 8,231.49 feet east from pre-

viously described meander corner to secs. 11 and 12, T. 24 N., R. 3 E., thence for east line run south 6,776.22 feet; thence west 293.42 feet; thence south 14° 30′ west 2,300 feet; thence south 8° 23′ 41″ west 1,681.67 feet to the meander line of Edwards Island.

For west line of east waterway, commence at a point on outer line of harbor reserve, which is 1,411.89 feet south and 9,073.14 feet east from Coast Survey signal, being also 1,930.46 feet north and 7,231.49 feet east from meander corner to secs. 11 and 12; thence run south 6,152.79 feet; thence east 293.42 feet; thence south 14° 30′ west 2,630.13 feet, to point of intersection with east line of west waterway.

Canal waterway.—For north line, commence at a point 6,764.68 feet south and 10,073.14 feet east from Coast Survey signal at Duwamish Head, also 3,422.33 feet south and 8,231.49 feet east from meander corner to secs. 11 and 12, T. 24 N., R. 3 E., thence south 45° east 707.11 feet; thence east to meander line. For south line, commence at a point 7,564.68 feet south and 10,073.14 feet east from said Coast Survey signal, also 4,222.33 feet south and 8,231.49 feet east from meander corner to said secs. 11 and 12, thence east to meander line.

DESCRIPTION OF HARBOR LINES AT BALLARD, WASHINGTON.

For the harbor line or the outer rim of the reserved area.—Begin at a point 1,824.76 feet north and 449.22 feet east of the United States Coast Survey signal marked X on the map, south of the mouth of Salmon Bay, which point is also 1,870.81 feet north and 341.04 feet east of the meander post corner to fractional secs. 9 and 10, T. 25 N., R. 3 E., thence north 21° 28′ 49″ east 1,988.09 feet; thence north 55° 07′ 32″ east 1,757.66 feet; thence north 18° 32′ 18″ east 3,506.97 feet; thence north 30° 42′ 14″ west 1,889.94 feet; thence north 14° 25′ 15″ east 1,264.85 feet; thence north 57° 58′ 22″ east 2,125 feet; thence south 32° 01′ 38″ east 300 feet to a point 501.53 feet north and 384.03 feet west of meander post corner to fractional secs. 34 and 35, T. 26 N., R. 3 E.

For the line bounding the inshore limit of the reserved area aforesaid.—Begin at a point 190.95 feet south and 247.25 feet east of the initial point of the outer rim of said area above described, and which point is also 1,679.86 feet north and 588.29 feet east of meander post corner to fractional secs. 9 and 10, T. 25 N., R. 3 E., thence north 21° 28′ 49″ east 1,984.53 feet; thence north 55° 07′ 32″ east 1,766.14 feet; thence north 18° 32′ 18″ east 3,677.63 feet; thence north 30° 42′ 14″ west 1,896.07 feet; thence north 14° 25′ 15″ east 1,090.93 feet; thence north 57° 58′ 22″ east 2,005.16 feet to a point of intersection with the outer rim above described.

Salmon Bay waterway.—Commencing at a point on the outer rim of the reserved area in front of Ballard Harbor, 1.279.77 feet north and 503.62 feet east of the initial point of the outer line of the reserved area aforesaid, thence running for the south side of Salmon Bay waterway, south 68° 31′ 11″ east 731.03 feet; thence south 33° 39′ 57″ east 2,190 feet; thence south 16° 32′ 30″ east 938.21 feet; thence south 16° 39′ west 558.41 feet; thence south 45° 27′ 08″ east 537.42 feet; thence south 85° 44′ 36″ east 1,145.16 feet; thence south 74° 32′ 20″ east 251.93 feet; thence south 54° 19′ 20″ east 550 feet; thence south 63° 12′ 29″ east 1,098.33 feet; thence south 88° 52′ 20″ east 1,270.25 feet; thence south 58° 19′ 58″ east 1,885.77 feet; thence south 29° 29′ 02″ east 1,361.30 feet; thence east 2,405 feet; thence south 50° 29′ east to the meander line.

And for the north side of said Salmon Bay waterway, commencing at a point 2,087.29 feet north and 1,068.47 feet east of the initial point or point of beginning of the outer line of the reserved area in front of the city of Ballard aforesaid, thence south 33° 39′ 57″ east 3,258.85 feet; thence south 7° 55′ 48″ east 688.58 feet; thence south 36° 44′ 51″ east 748.80 feet; thence south 61° 26′ 37″ east 759.38 feet; thence south 54° 19′ 20″ east 951.61 feet; thence south 67° 51′ 39″ east 504.17 feet; thence north 75° 28′ 55″ east 1,874.87 feet; thence south 57° 37′ 49″ east 1,083.34 feet; thence south 45° east 2,354.67 feet; thence east 1,580 feet; thence south 43° 28′ east to the meander line.

T T 41.

ESTABLISHMENT OF HARBOR LINES AT HOQUIAM HARBOR, WASHINGTON.

LETTERS OF THE BOARD OF STATE LAND COMMISSIONERS.

BOARD OF STATE LAND COMMISSIONERS,
Olympia, Wash., October 8, 1894.

SIR: We have been instructed by the board of State land commissioners to certify to you that the location of harbor lines in front of the cities of Seattle* * * * * and Hoquiam, this State, appeared to be

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* For action concerning establishment of harbor lines at Seattle see pages 3543-3546.

an absolute necessity; that it was important that these lines be established at the earliest date practicable, and accordingly this board agreed upon and located the lines in front of the aforesaid cities and now respectfully request that, in pursuance of section 12 of the river and harbor act of September 19, 1890, you appoint a Board of United States Engineers to examine, consider, and report upon these lines with the end in view of securing the Government approval of the same.

In this connection it may be well to state that a Board was directed on a former occasion by the Secretary of War to establish these harbor lines in conjunction with other harbor lines in the State, but that, owing to litigation over the lines in front of Seattle, Tacoma, and Hoquiam, the Board did not act at these places.

This commission, as the successor of the old State harbor line commission, is charged by the constitution and laws of the State of Washington with the duty of making reservations upon the water front of the various harbors within its limits, in the interests of commerce and to the end that these reservations within certain harbor lines may be owned and controlled by the State, so that commercial facilities may be provided thereon, which shall at all times afford cheap, convenient, and ready access to the navigable waters of the State by all its people. These reservations are to be from 50 to 600 feet in width at the discretion of this commission. The laws of the State provide for the sale, under the direction of this commission, of all the tide lands within the inner harbor lines of these reservations, after they shall have been properly located and established as required by law. The tide lands, as thus described, in many localities comprise extensive areas which, in the estimation of the general public, should be sold at an early day, so that the many improvements which are contemplated thereon may go forward; but these tide lands can not be sold until the harbor lines, as required by law, are first established.

* * * * * * *

The work of preserving, maintaining, and improving the interests of commerce and navigation in this State and of making preparation for their future development by both the State and General Government will be greatly facilitated by your favorable consideration of the application herein made.

We have the honor to be, very respectfully, yours,

W. T. FORREST, *Chairman.*
E. D. COWEN, *Secretary.*

Hon. DANIEL S. LAMONT,
Secretary of War.

BOARD OF STATE LAND COMMISSIONERS,
Olympia, Wash., November 1, 1894.

DEAR SIR: In compliance with your letter of instructions, dated October 17, I forward by express to-day, addressed to the Secretary of War, a tracing* of the harbor lines established under authority of the State of Washington in front of the cities of Seattle,† Ballard,† and * * * also a map* of the harbor lines established in front of the city of Hoquiam. Your letter of instructions calls for tracings, but the

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* Omitted.

† For action concerning establishment of harbor lines at Seattle and Ballard see pages 3543–3547.

board is not in possession of the tracings of the harbor lines in front of Hoquiam; therefore send you a plat which we trust will answer your purpose.

I have the honor to be, very respectfully yours,

E. D. COWEN, *Secretary.*

THOMAS LINCOLN CASEY,
Brig. Gen., Chief of Engineers, U. S. A.

[First indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
November 12, 1894.

Respectfully referred to Col. George H. Mendell, Corps of Engineers, for report on the harbor lines proposed for * * * Hoquiam. Colonel Mendell is authorized to call on Capt. T. W. Symons, Corps of Engineers, for any information or assistance desired.

By command of Brig. Gen. Casey:

H. M. ADAMS,
Major, Corps of Engineers.

[Second indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., November 27, 1894.

Respectfully returned to the Chief of Engineers with report upon harbor lines of * * * Hoquiam.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

[Third indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
December 11, 1894.

Respectfully submitted to the Secretary of War.

The board of land commissioners of the State of Washington submits for the action of the War Department drawings showing harbor lines established by the State authorities for * * * Hoquiam, in that State.

The drawings have been under consideration by Col. George H. Mendell, Corps of Engineers, and attention is respectfully invited to his report of the 27th ultimo, herewith.

* * * * * *

For the harbor of Hoquiam Colonel Mendell recommends that the Secretary of War establish pierhead lines only. He has made some modifications of the lines proposed by the State board, which he states in his report are indicated by *brown lines* on the original drawing marked A.*

I have had made in this office a tracing on which the lines are indicated in *red.* I recommend that the heavy red lines on this tracing be established as pierhead lines for Hoquiam Harbor and that the Secretary of War place his approval on this tracing.

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

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* Omitted.

[Fourth indorsement.]

WAR DEPARTMENT, *December 12, 1894.*

Approved as recommended by the Chief of Engineers.

DANIEL S. LAMONT,
Secretary of War.

REPORT OF COL. G. H. MENDELL, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
San Francisco, Cal., November 27, 1894.

GENERAL: As required by the Department indorsement * * * of November 12, 1894, the following reports are respectfully submitted in the matter of harbor lines in front of * * * Hoquiam, Wash.

* * * * * * *

HOQUIAM.

It is recommended that the action of the Department be limited to the outer or pierhead lines. These proposed lines at the mouth of the Hoquiam River, shown in red, are objectionable in the fact that they contract the entrance unnecessarily, thereby sacrificing convenience and other important considerations.

A modification of the pierhead line around the west side of the entrance, shown on the map* in brown, is recommended. It consists of a rectilinear portion 2,000 feet long tangent to the circular portion, which is drawn to a radius of 1,350 feet.

On the Chehalis River front the pierhead line adopted by the commission is extended to include behind it the best water, making too great encroachment upon the river channel. It is recommended that this line be retired 250 feet at Waterway No. 2 and adjusted, as shown in brown, on either side of the waterway and to the mouth of Hoquiam River.

Very respectfully, your obedient servant,

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

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* Omitted.

APPENDIX U U.

IMPROVEMENT OF WILLAMETTE AND LOWER COLUMBIA RIVERS AND THEIR TRIBUTARIES, OREGON AND WASHINGTON.

REPORT OF MAJ. JAMES C. POST, CORPS OF ENGINEERS, OFFICER IN CHARGE, FOR THE FISCAL YEAR ENDING JUNE 30, 1895, WITH OTHER DOCUMENTS RELATING TO THE WORKS.

IMPROVEMENTS.

1. Mouth of Columbia River, Oregon and Washington.
2. Columbia and lower Willamette rivers, below Portland, Oreg.
3. Columbia River, between Vancouver, Wash., and mouth of Willamette River.
4. Canal at the Cascades, Columbia River, Oregon.
5. Columbia River at Three Mile Rapids and boat railway from The Dalles Rapids to Celilo Falls.
6. Willamette River, above Portland, and Yamhill River, Oregon.
7. Cowlitz River, Washington.
8. Youngs and Klaskuine rivers, Oregon.
9. Gauging waters of Columbia River, Oregon and Washington.

EXAMINATIONS AND SURVEYS.

10. Clatskanie River, Oregon.
11. Tualiton River, Oregon.
12. Lewis River, Washington.
13. Yamhill River, Oregon, up to the town of McMinnville.
14. Columbia River, below Tongue Point, by way of the southern channel, in front of Astoria, Oreg.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., July 10, 1895.

GENERAL: I have the honor to transmit herewith annual reports of the works of river and harbor improvement in my charge for the fiscal year ending June 30, 1895.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

U U 1.

IMPROVEMENT OF THE MOUTH OF THE COLUMBIA RIVER, OREGON AND WASHINGTON.

The project for this work was adopted in 1884, and contemplates securing and maintaining a navigable channel 30 feet deep at low water across the bar at the mouth of the river by concentrating the

ebb currents flowing between Point Adams, Oregon, and Cape Disappointment, Washington, separated by a distance of 10 miles measured upon the crest of the bar. Originally these currents produced two or three variable and insufficient channels, and it was proposed to replace these by a single channel of such dimensions as would accommodate the commerce of the river, both present and prospective. To accomplish these results a jetty composed of random blocks of stone placed upon brush mattresses was designed. This was to extend from the shore near Fort Stevens, across Clatsop Spit, in nearly a straight line toward a point about 3 miles south of Cape Disappointment. The height and length of the jetty were to be finally determined as the work progressed by the effect produced, but it was to be kept as low and as short as was consistent with the object to be attained, both for reasons of economy and to prevent unnecessary obstruction to the inflowing tides.

In the latter part of 1884 the necessary preparations for commencing the work were made, and early in 1885 active operations began. These consisted in the construction of wharves, buildings, etc., and an elevated railway over the site of the jetty from which the mattresses were to be lowered in place and the stone covering dumped upon them. As the elevated railway advanced, mattresses were laid and ballasted, and these operations were continued until the work was extended $4\frac{1}{4}$ miles to a point 3 miles south of Cape Disappointment, or nearly the entire length proposed. The portions of the jetty inshore were also raised as the work advanced. In March, 1893, the results obtained being satisfactory, action was taken to determine the height to which the work should be raised to secure its permanence and maintain the capacity of the newly formed channel. This question was referred to a Board of Engineer Officers, who recommended that the height of the work, in its completed state, should be 12 feet above datum at the shore, and slope to 10 feet at Station 122 (1.8 miles) and continue to slope from thence to 4 feet above datum at the outer end. Datum is taken as the mean of the observed lower low waters. This Board also recommended, as an additional protection to the work and to add to the permanence of the sands that had accumulated on both sides, the construction of four groins or spurs on the channel side of the jetty.

At the close of the last fiscal year the jetty had been raised to the full height from the outer or sea end for a distance of 10,000 feet, or nearly 2 miles, and for 1,420 feet at the inshore end. Between these portions the height varied from 7.5 feet above low water to 10 feet above low water. The height for 2,200 feet at the outer end had, however, been reduced from 1 to 4 feet as the result of heavy gales in the latter part of 1893, which also destroyed 1,800 feet of the elevated railway at the outer end. The two outer groins of the four contemplated by the project had also been constructed.

At the close of the month of March, 1894, operations were suspended as the near exhaustion of the funds available would not permit the continuance of the work.

Soundings taken in the following May and June indicated that the channel previously formed had not only been maintained, but had improved; that the 29-foot channel was somewhat wider; that the distance between the 27-foot and 25-foot contours had increased to $1\frac{1}{8}$ miles and $2\frac{1}{8}$ miles, respectively, and that the sand shoals that had formed on both sides of the jetty had greatly increased both in height and area.

OPERATIONS DURING THE YEAR.

As soon as information was received that the river and harbor act of August 17, 1894, had become a law, active measures were at once taken to make such repairs as were needed upon the elevated railway and the working plant, including engines, cars, boats, etc., to enable operations to be resumed at an early date.

September 22, bids were opened, after advertisement, for the delivery on barges of 100,000 tons of rock, more or less, with the privilege of extending the amount to 200,000 tons if required, and the contract was awarded to John Kiernan, of Portland, the lowest bidder, for 48 cents per ton, subject to the approval of the Chief of Engineers, the rock to be supplied from Fishers Landing, near Vancouver, Wash. The contract was approved by the Chief of Engineers October 1, 1894, and the delivery of rock was commenced October 15 and was continued until the end of the fiscal year, except during the months of January and February, when work was suspended on account of bad weather. Advantage was taken during the suspension of work to put all the plant in good order, especially the tow steamer *Cascades*, which required extensive repairs. 136,900.1 tons of rock has been placed in the jetty and shore revetment during the fiscal year. From the date of resuming work on March 1, to the end of the fiscal year, rock has been delivered and placed at an average rate of 22,355 tons per month.

The total amount of rock placed in the work since its commencement to the end of the present year has been 863,131.9 tons, and this has cost, including all expenses of every kind connected with the work, such as elevated railway, mattress foundation, plant of every description, transportation, supervision, etc., an average of $2.20 per ton. Nearly all the rock used has been transported a distance of at least 108 miles from the quarries to the work.

During the year rock has been added to the work, wherever needed, between Stations 230 and 53, or over a distance of about $3\frac{1}{4}$ miles, and this portion of the work has been practically raised to the required height and completed. No attempt has been made to again bring the outer 2,000 feet up to the level prescribed. This part remains about the same as reported last year. It has twice been raised to the required level, but both times the heavy seas removed the top covering of rock, and the second time a large portion of the railway over it was destroyed. Groins 3 and 4 have been completed, and between Stations 53 and 40 the jetty has been given increased width of base to withstand the heavy seas which break in this locality, and the work remains at the same height as last year. It is proposed to carry this increase of base to the shore line. With the exception of this increase of base the entire jetty, including the four groins, is now completed, except between Stations 53 and 40, a distance of 700 feet.

Operations upon the shore revetment were commenced in March, and the elevated track for laying this work has been completed. The length of track constructed is 3,025 feet, and the foundation mats for the work have been laid for a distance of 2,632 feet. The total length of the shore revetment when completed, including the work previously done, will be 3,675 feet.

A complete survey of the area included between Smiths Point on the Oregon shore and Point Ellice on the Washington shore and the sea, including the channel over the bar, was made during the months of May and June to ascertain what changes had taken place within the mouth of the river as well as upon the bar since the last surveys were made.

This survey shows but little, if any, change in the position of the shoals or in the location or direction of the channel inside the bar, but upon the bar there has been a decided improvement in the channel. By referring to the map forwarded herewith it will be observed that there is a direct channel between the sea and the river, 30 feet in depth at low water and seven-eighths of a mile wide, and that within this channel there is a depth of at least 31 feet at low water over a width of one-half mile. The object of the project for this work, which was to obtain a channel 30 feet deep at low water over this bar, has therefore been accomplished, and there appears to be nothing further to be done except to leave the work in such condition that this channel will be maintained. So far as can be seen at the present time, this only involves completing the small portion of the jetty remaining unfinished and the completion of the shore revetment. It is estimated that this work will consume about four months, at the end of which time the entire improvement will be completed. The total amount appropriated for this work has been $2,025,680, and this amount will be sufficient to complete it. Its estimated cost was $3,710,000, and its construction will therefore cost $1,684,320 less than the estimate. This remarkable exhibit has been principally due to the fact that the appropriations made from time to time have proved sufficient to practically maintain continuous operations. The work has been done by hired labor, and the materials have, as a rule, been purchased by contract. During the last six years there have been but two suspensions of work because of want of funds, one of twenty days, and one of four and one-half months' duration. It is fortunate that this work is now rapidly drawing to a close and that further expenditure for renewing the elevated track will be unnecessary. The violent action of the sea and decay are fast destroying this part of the work, and it has only been maintained in an efficient condition up to the present time by constant inspection and continual repairs.

Mr. G. B. Hegardt has continued in local charge of the work, and to him belongs a large portion of the credit for bringing this work so rapidly and skillfully toward successful conclusion. His report, which contains additional details of the year's work, is submitted herewith.

APPROPRIATIONS.

Act of—		Act of—	
July 5, 1884	$100,000	July 13, 1892	$350,000
August 5, 1886	187,500	August 17, 1894	338,180
August 11, 1888	500,000		
February 22, 1890	75,000	Total	2,025,680
September 19, 1890	475,000		

Money statement.

July 1, 1894, balance unexpended		$18,168.90
Amount appropriated by act of August 17, 1894		338,180.00
		356,348.90
June 30, 1895, amount expended during fiscal year		167,726.36
July 1, 1895, balance unexpended		188,622.54
July 1, 1895, outstanding liabilities	$21,296.56	
July 1, 1895, amount covered by uncompleted contracts	36,859.15	
		58,155.71
July 1, 1895, balance available		130,466.83

Abstract of proposals for furnishing and delivering 100,000 tons, more or less, of rock for jetty at mouth of Columbia River, received and opened at Portland, Oreg., by Maj. James C. Post, Corps of Engineers, on the 22d day of September, 1894.

No.	Name and address of bidder.	Price per ton.	Aggregate.
		Cents.	
1	John Kiernan, Portland, Oreg	48	$48,000.00
2	Oak Grove Rock and Contract Co., Portland, Oreg	48¼	48,250.00
3	Pacific Paving Co., Portland, Oreg	51½	51,500.00
4	McCubbin & Jacobsen, Portland, Oreg	51⅞	51,875.00
5	McKenzie & Glinn, Portland, Oreg	53	53,000.00
6	J. E. Smith, Portland, Oreg	54½	54,500.00
7	Pomeroy & Smith, Oswego, Oreg	56⅓	56,333.33
8	Paquet, Minsinger & Smith, Portland, Oreg	59	59,000.00
9	N. J. Blagen, Portland, Oreg	63½	63,500.00
10	Oskar Huber, Spokane, Wash	68⅓	68,333.33
11	John E. Howard, Killgaver, Oreg	69	69,000.00

Contract awarded to John Kiernan and executed under date of September 24, 1894.

REPORT OF G. B. HEGARDT, ASSISTANT ENGINEER.

OFFICE OF UNITED STATES ASSISTANT ENGINEER,
Fort Stevens, Oreg., July 1, 1895.

MAJOR: I have the honor to submit the following report of operations on the improvement of the mouth of the Columbia River, Oregon and Washington, for the fiscal year ending June 30, 1895:

For want of funds operations were suspended from the beginning of the fiscal year until the passage of the river and harbor act in August, when work was at once resumed and has since been vigorously prosecuted with the exception of the usual suspension of rock delivery in January and February on account of severe weather and to permit the overhauling of the rolling stock, floating plant, and tracks.

JETTY TRAMWAY.

No extension was made to the tramway during the year.

Repairs to and the care of the tracks for the running of the rock trains has been the principal work done.

Immediately after the passage of the river and harbor act a small force of men was set to work repairing the tramway tracks, and about 85 decayed stringers were replaced, a number of caps "fish-plated" and 9 piles driven for repairs between Stations 30 + 00 and 90 + 00; bad "kinks" were taken out and the switches and "cross overs" overhauled.

In January, during the suspension of rock delivery, about 100 badly corroded rails were taken out and more decayed stringers removed.

October 27, 298 feet of tramway, from Station 229 + 50 to Station 232 + 48, was practically destroyed by floating piling from the cigar-shaped raft, which was broken up while being towed to San Francisco from the Columbia River.

During southerly storms in January, which were accompanied by the highest tides known for years, the tramway tracks were further damaged. The 300 feet of track at the outer end of the jetty, which had been standing undisturbed since its construction, was washed away, and between Stations 223 + 00 and 229 + 00 the tracks were so badly damaged as to be beyond repair.

From Station 229 + 00 to the outer end, Station 250 + 40, a distance of 2,140 feet, the tramway tracks have now entirely disappeared, and from Station 223 + 00 to Station 229 + 00, a distance of 600 feet, they are too much damaged to be used. From Station 223 + 00 to the shore the trains can still be run.

Rails have been taken up from the north track from the end in as needed for use in the construction of the groin and shore revetment tracks and to replace badly corroded rails near the shore end of the tramway.

The three "cross overs" at Stations 214 + 00, 184 + 00, and 156 + 00 were taken up to permit the dumping of rock on the line of the jetty. The condition of the tramway is anything but good, and this is true particularly of the first mile and a half. The piling, caps, and stringers are becoming much decayed and the rails badly corroded, and constant watchfulness is required to prevent accidents.

Three track walkers and one carpenter with helper are constantly employed to care for the tracks during the running of rock trains.

JETTY.

The mattress work of the jetty was completed in 1892 and no mat making in the jetty proper was done during the year.

The amount of rock received and placed on the jetty, groins, and shore revetment during the fiscal year was 136,900.1 tons. This was all furnished by John Kiernan, Portland, Oreg., under contract of September 24, 1894. The total amount of rock received for this work since its commencement is 863,131.9 tons.

The first delivery of rock under the present appropriation was made October 15 and continued without interruption until January 4, when the usual suspension during the stormy months of January and February took place. Rock delivery was again resumed on March 1. The rock received was distributed over the jetty, groins, and shore revetment as follows: On the jetty, 88,656.1 tons; the groins, 35,413.9 tons, and on the shore revetment, 12,830.1 tons.

The rock dumped on the jetty was placed between the following stations: Station 25 + 80, the root of the jetty. to 52 + 00, 7,942.2 tons; 52 + 00 to 150 + 00, 77,682.9 tons, and 150 + 00 to 230 + 00, 3,085 tons.

The bents of the tramway tracks as far out as Station 52 + 00 are only 10 feet between centers—too close together to permit of large-size rock being dumped from the south track and between the tracks, as is done beyond this station, where the bents are 16 feet apart. For this reason practically all the rock placed from this part of the tramway during the previous years was dumped from the north track and outside the main line of the jetty, forming a narrow ridge of rock with steep slopes. This was necessary at this time to protect the tracks from being damaged by the floating logs and drift which lodged against the first mile of the jetty.

The 7,942.2 tons of rock placed between the root of the jetty and Station 52 + 00 during the fiscal year was nearly all of small size—4 tons and under—and was all dumped from the south track and between the tracks for the purpose of forming a backing for the narrow ridge of rock in front of the trestle work and at the same time increase its base. About 6,000 tons more of small-size rock will be required to provide this sort of backing for the entire distance between these two stations. The rock distributed between Stations 52 + 00 and 150 + 00 was for the purpose of raising the jetty to the required height and increasing its width. Between Stations 150 + 00 and 230 + 00, 3,085 tons was distributed, and about two-thirds of this amount was used to fill up the low places in the jetty where the "cross-overs" of the tramway had been taken up. The remainder was dumped between Stations 220 + 00 and 230 + 00 to raise the jetty where the top rocks had been washed off by the action of the sea during last winter's storms.

By the revised project of the Board of Engineers, approved June 9, 1893, the top of the jetty when completed at the shore end, Station 25 + 80, should be at reference 12, above datum plane, mean lower low water, and should slope thence to reference 10, at Station 122 + 90, 1.8 miles, and thence to reference 4, at the outer end.

At the end of the last fiscal year the height of the jetty was reported as follows: From Station 25 + 80, the root of the jetty, to Station 40 + 00 the jetty was up to the desired height; from Station 40 + 00 to Station 95 + 00 it was practically up to within 2.5 feet of the required height for the entire distance, and from this latter station the rock sloped from reference 9 to reference 7.5, mean high water, at Station 105 + 00. From Station 105 + 00 to 150 + 00 the top of the jetty was practically up to mean high water.

Between Station 150 + 00 and the end, Station 250 + 00, the jetty had been raised to the established height and was considered complete.

From the shore to Station 105 + 00 the height had been attained by dumping the rock in a narrow ridge to better secure the tramway from damage by drift.

With the rock received and distributed over the jetty during the fiscal year the following results were attained: Between Stations 150 + 00 and 230 + 00, completed last year, where the top rocks near the latter station had been washed off during the winter storms, the jetty was again brought to the proper level and the low places under the "cross overs" that were taken up were filled.

From Station 150 + 00 and in to Station 53 + 00 the jetty was raised to the completed height with the exception of the two places, 200 feet each, where the "cross overs" of the tracks are still left in for convenience in handling rock trains, and the top widened where the rock had been dumped in a narrow ridge. Between Stations 58 + 00 and 69 + 00, however, the top of the jetty will require to be widened somewhat. This portion of the jetty may then be considered as completed, though it is believed it will be deemed advisable to finish off the exterior slope and fill the larger interstices with rock of small size.

The rock placed from Station 53 + 00 to the shore was, as already stated, dumped to form a backing for the narrow ridge of rock in front of the short bents of the tramway and has not increased the height of the jetty, which, for this distance, remains at the levels reported last year. The destruction of the outer end of the tramway, which has been going on gradually during the last two years, has prevented

the restoration to the completed height of that portion of the jetty, where between 4,000 and 5,000 tons of rock was washed off by the action of the sea during the winter storms of 1893-94; that is, on 2,000 feet at the outer end. The accompanying map, with profile, gives the height of the jetty throughout its entire length.

During the past winter some very severe gales were experienced, together with extremely high tides, but the jetty sustained no damage worth mentioning. About 1,000 tons of rock was washed from the top of the jetty between Stations 220+00 and 230+00.

No disturbance of rock work was observed inside of Station 220+00. Frequent measurements were taken during the year of the height of the jetty, but no signs of settling or sinking of the rock have appeared.

The sands on each side of the jetty were located early in June, at a stage of tide of about mean lower low water, plane of reference. Last year these sands were taken when the tide was 2 feet lower, which probably accounts for the apparent decrease in area in places; but taking the sands as a whole there is practically no change from last year, so far as size is concerned.

Toward the lower end of the spit, and following the shore line of Point Adams, it has moved closer to the shore and reduced the width of the narrow channel from 600 feet last year to from 150 to 200 feet. This channel is the only outlet of tide, below the average height, for the flood water from the large pocket at the shore end of the jetty. Its depth has been considerably reduced and carries now only 9 feet in the deepest place at low water as against 18 feet last year. The outlet of this channel has been forced to the south and closer to the shore over one-quarter of a mile and is practically closed at low water, having a depth of but about 1 foot.

Though the spits have not increased in area, they have built up considerably in height, and particularly so the large south spit. Last year this was bare in spots at an elevation of 6 feet above the plane of reference, but the larger portion of it at 5 feet. This spit has now an elevation of from 6 to 8 feet.

The spit on the north side of the jetty has also increased in height and is bare at a 4 to 6 foot tide.

The spits are closing in on the jetty on both sides, and are now even with the rock-work in many places.

GROINS.

Groins No. 1, at Station 228+00, and No. 2, at Station 156+00, were completed last year, and No. 3, at Station 88+00, and No. 4, at Station 52+00, during the fiscal year.

As soon after the passage of the river and harbor act as material could be delivered the work of constructing the tracks for Groins 3 and 4 was commenced, and completed in December, with the exception of 128 feet for Groin No. 3, at which time pile driving was suspended on account of stormy weather. The 128 feet of track, short on Groin No. 3, was finished early in February. The required mattress work for these groins was placed and rock dumped to the required height. Groins 3 and 4 are each 1,000 feet long.

The following amounts of rock were placed on the groins during the year: No. 1, 905.2 tons; No. 2, 2,053.2 tons; No. 3, 16,477 tons, and No. 4, 15,978.5 tons.

The rock in No. 1 had either settled or been washed off by the sea, and as soon as delivery of rock was commenced, in October, nearly 1,000 tons was dumped on this groin, restoring it to the completed height. A few days later, October 27, the tramway tracks outside of the root of this groin were destroyed by floating piling from the cigar-shaped raft, and in January the tracks of the groin commenced to go and only a small portion of them now remain. 2,053.2 tons of rock was distributed over Groin No. 2 for the purpose of raising it to the height of the jetty at its root and gradually sloping it to about 2 feet below low water at its outer end. Groins 3 and 4 are finished in a similar manner.

The effect of the groins has been a shoaling between all of them, as compared with last year, and between Nos. 3 and 4 as much as 6 to 8 feet.

The total amounts of rock placed in the completed groins are: In No. 1, 6,188.2 tons; No. 2, 5,292 tons; No. 3, 16,477 tons, and No. 4, 15,798.5 tons.

SHORE TRESTLE.

During high tides in January, 12 piles were washed out. These were replaced. The switches were overhauled, and about 400 ties put down; otherwise no work was required with the exception of the ordinary care of the tracks.

WHARVES.

During the stormy weather of January, accompanied by very high tides, 35 piles in the wharf approaches were washed away or broken off by the floating logs or trees. The necessary repairs were made. Ten new fender piles were driven on the face of the main wharf.

Between two of the old wharves, for a distance of nearly 500 feet, the tracks had settled, in places, as much as a foot. The rails and planking were removed and the tracks blocked up.

To facilitate the discharge of rock on the old wharf, two turntables were put down and the tracks altered to suit the turntables.

During the suspension of rock delivery, in January, the timbers for the crossing of the revetment track across the wharf tracks were put down.

SHORE REVETMENT.

The work on the revetment track was commenced in March and completed at the end of the fiscal year. During this time 2,525 feet was constructed and 500 feet of the old track repaired, making a total of 3,025 feet of track.

The accompanying drawing shows the position of the revetment, which, when completed, will have a total length of 3,675 feet.

The mattress foundation is 40 feet wide and consists of one mat 20 feet wide and 4 feet thick placed immediately in front of the track, and a second, just back of this, also 20 feet wide, but only 2.5 feet thick. These foundation mats were placed for a distance of 2,632 feet, and are within 238 feet of the end of the track.

The amount of rock distributed over the revetment was 12,830.1 tons, a sufficient quantity to well secure the mattress work.

To carry the revetment tracks over the wharf tracks five complete railroad crossings were made on the works.

Principal materials received.

Rock	tons	136,900.1
Fascines	cords	3,795.8
Poles		3,188
Lumber	feet	499,893
Piles		500
Wood	cords	658
Coal	tons	982

GRIDIRONS AND SIDE TRACKS.

The wharf gridiron, which was partly destroyed by the surf during the extreme high tides in January, was repaired, and another one, 20 by 110 feet, on the opposite side of the tracks, was built for the purpose of storing small rocks used as a foundation course on the mattress work of the shore revetment, together with a short side track leading to it.

The brush gridiron near the Y was replanked and otherwise repaired, and an addition of 120 feet built to the pole gridiron.

PLANT.

The whole plant has been kept in good repair during the year. All the repairs to the plant have been made on the work and in the workshops of the place.

The tow boat *Cascades*, tug *George H. Mendell*, and most of the barges were hauled out and their hulls repaired in Portland.

Dump cars.—It was necessary to rebuild 16 of the geared dump cars, the woodwork having become so badly decayed as to cause the body of the cars to crush under heavy loads, and on 21 cars the woodwork was renewed in parts.

In addition to the cars rebuilt and repaired, 11 were scraped and repainted. Eleven new movable boxes were made and 275 repaired.

Locomotives.—The ordinary running repairs during the working season were attended to, and in addition to this all the locomotives were given a good overhauling.

Derricks.—One new derrick was made and put up. New stiff legs were provided for two derricks, and one spare boom and mast made.

Pile driver.—The engines, boiler, and jet pump of the tramway driver were overhauled, the ironwork scraped, and both the woodwork and ironwork painted before the driver was set to work on the groin tracks.

For the construction of the shore revetment tracks a small pile driver, mounted on four trucks, was built at a cost of about $600, exclusive of the hoisting engine and hammer, both of which were on hand.

Tug.—The steam tug *George H. Mendell* was hauled out on the ways in Portland, the hull calked and painted, and the stern bearing and machinery overhauled. The tug has been kept well painted, inside and out, during the year.

Barges.—All the barges were more or less repaired while engaged in carrying rock from the quarry, the minor repairs being mostly to the guards and decks.

Before delivery of rock began in October nearly all of the barges had their hulls above light-draft line calked and some small repairs made to the decks. This spring new sheathing was placed on barges Nos. 7, 8, 9, and 10, and the side towing bitts

renewed on all the barges. All the barges were thoroughly painted, the cabins being painted inside and out.

Quarters and buildings.—All the quarters and other houses around the parade ground were whitewashed.

Water supply.—The pipe line from the office to the wharf was taken up and cleaned out.

The well used in connection with the steam pump was cleaned out and new sheet piling put down.

Surveys.—A hydrographic survey of the river, from Astoria to the sea, was commenced on May 14 and completed by the end of the fiscal year. All conditions were exceptionally favorable for this work and the results obtained are very satisfactory.

The soundings are reduced to the plane of the mean of the lowest low waters and are shown upon the chart herewith.

The survey made of the bar last year showed a narrow 29-foot channel across it, and the distance measured across the bar between the 30-foot curves had been reduced to 1,500 feet. The width of the 27-foot channel was $1\frac{1}{8}$ miles and that of the 25-foot channel $2\frac{1}{8}$ miles.

The present survey shows important and very gratifying improvements in the channel.

It will be noticed that there is a straight channel over the bar one-half mile in width, having a depth nowhere less than 31 feet. For a width of seven-eighths of a mile it has a least depth of 30 feet, and for a width of about 2 miles the depth is not less than 24 feet.

Aside from the great improvement of the channel across the bar, very few changes were found. The 24-foot curves occupy practically the same position as those of last year, except the south one, which was forced slightly outward, and the increased depth and width of the present channel is entirely to the north of and joining that which existed at the time last year's survey was made.

About the same depth of water is found on the large sand spit in prolongation and west of the jetty, but as this is approached a considerable shoaling has occurred.

Along the north side of the jetty, from the outer to the shore end, there is a decrease in the depth of water, caused by the construction of the four groins.

On the north side of the jetty, though the large sand spit has not increased in area, its height is greater by from 1 to 2 feet, and a large portion of it is now bare at ordinary high water.

At the head of Sand Island the depth is practically the same as it was last year, as is also the case in the "cut-off" at its lower end, though the channel is somewhat narrower and forced a short distance nearer to Peacock Spit.

From Fort Stevens to Smiths Point practically the same depth of water prevails as is shown on the last Coast Survey chart. The soundings in front of Astoria are from a survey made by Assistant Engineer R. Warrack in October and November, 1894.

The following drawings accompany this report:

Plan and profile showing extent of jetty construction June 30, 1895, and chart of survey of the mouth of the Columbia River, May and June, 1895.

Very respectfully, your obedient servant,

G. B. HEGARDT, *Assistant Engineer.*

Maj. JAMES C. POST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

The following statistics bearing upon the improvement of the mouth of the Columbia River have been compiled from the most reliable sources attainable, including reports from the collector of customs at Portland and Astoria and from the Chamber of Commerce at Portland, Oreg.

Arrivals and clearances of vessels at Astoria, Oreg., during the year ending December 31, 1894.

[From collector of customs, Astoria, Oreg.]

Vessels.	Coastwise.		Foreign ports.				Total.	
			American.		Foreign.			
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
Arrived	508	337,482	9	6,712	46	68,686	563	404,975
Cleared	492	326,645	10	5,741	10	18,394	512	345,470
Total	.....	.....	.....	.....	.....	.....	.....	750,445

Commerce for year ending December 31, 1894.

Exports to foreign countries	$89,880
Shipments to domestic ports	27,553
Imports	80,290
Duties collected	84,240

Arrivals and clearances of vessels at Portland, Oreg., during the year ending December 31, 1894.

Vessels.	Coastwise.		Foreign ports.		Total.	
	No.	Tonnage.	No.	Tonnage	No.	Tonnage.
Arrived	170	206,005	100	144,811	270	350,816
Cleared	144	159,227	100	138,840	244	298,067
Total						648,883

Commerce for year ending December 31, 1894.

Value of exports to foreign countries	$3,841,316
Value of imports from foreign countries	760,303
Duties collected on imports	222,099

Comparative statement of shipments of wheat and flour from Portland for the past ten years.

Year ending—	Wheat.			Flour.		
	Foreign.	Domestic.	Total.	Foreign.	Domestic.	Total.
July 31—	*Centals.*	*Centals.*	*Tons.*	*Barrels.*	*Barrels.*	*Tons.*
1885	3,147,902	521,834	183,487	198,207	182,316	38,052
1886	3,971,756	1,349,740	266,075	353,869	187,763	54,163
1887	3,042,316	711,872	187,709	383,773	137,908	52,168
1888	3,203,108	1,259,263	223,119	486,456	157,655	64,411
1889	2,689,686	559,953	162,482	510,875	144,151	65,503
1890	1,752,879	343,690	104,828	411,751	111,681	52,343
1891	2,937,653	1,213,562	207,561	491,135	147,756	63,889
1892	3,531,919	1,016,194	227,406	377,711	151,359	52,907
1893	3,067,406	750,739	190,907	414,564	164,496	57,906
December 31, 1893	3,390,103	756,433	207,327	395,961	166,062	56,202
December 31, 1894	3,750,195	1,127,915	244,405	297,809	156,734	45,454

Statement of principal articles shipped from and received at Portland by deep-sea vessels during the year 1894.

Articles.	Tons.	Articles.	Tons.
SHIPMENTS.		RECEIPTS.	
Flour	45,454	Cement	34,314
Wheat	244,405	Coal	11,091
Oats	6,755	Salt	2,771
Barley	19,175	Rice	1,368
Flaxseed	19,731	Tin and tin plate	425
Wool	2,058	Glass	179
Salmon	2,336	Hemp and jute	933
Timber	878	Tea	173
		Sugar	915
Total	340,792	Coffee	103
		Total	52,272

IMPROVEMENT
OF
MOUTH OF THE COLUMBIA RIVER.

Survey made May–June, 1895, under the direction of
MAJOR JAMES C. POST, CORPS OF ENGINEERS. U.S.A.

C. B. HEGARDT, ASSISTANT ENGINEER.

Soundings are expressed in feet and show the depth at the average of the lowest low waters.

To accompany annual report for the fiscal year ending June 30. 1895.

Major, Corps of Engineers U.S.A.

PACIFIC OCEAN

WASHINGTON

OREGON

CAPE DISAPPOINTMENT

North Head

Mc. Kenzie Head

Ilwaco

CHINOOK

B

Pt.

A

K

E

R

CHANNEL

CHANNEL

PEACOCK SPIT

REPUBLIC SPIT

RUSSIAN ISLAND

White Point

Chinook Pt.

Pt. Ellice

Knappton

Chin. Pt.

McGowan

Pt. Adams

Ft Stevens

LIGHT

CLATSOP SPIT

Desdemona Sands

Upper Mud Flats

Sand

Flavel

Tansy Pt.

Smith Pt.

ASTORIA

YOUNGS BAY

YOUNGS R.

N.P. Trestle

WHISTLE

C.M.S.

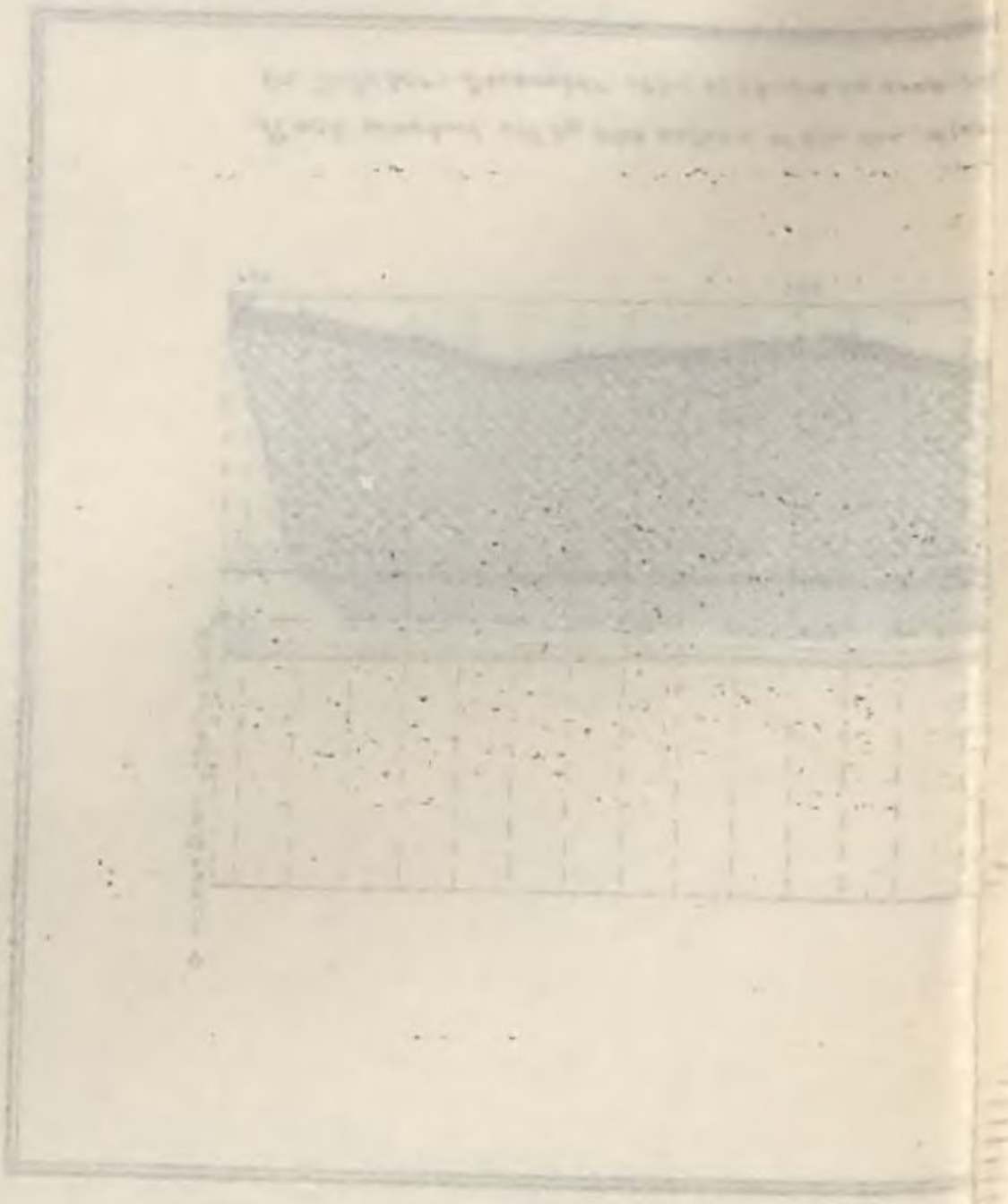
COLUMBIA RIVER LIGHTVESSEL No. 50
2 F.W. (WHISTLE)

Notes. Positions of buoys are as on June 30, 1895.
The soundings in front of Astoria are from a survey made October–November, 1894.

Statute Miles.
Nautical Miles

Eng 54 1

54 1


SHOWING EXTENT
OF LAND

Registered tonnage over Columbia River Bar.

INWARD TO ASTORIA AND PORTLAND.

Year.	Deep-sea sailing vessels.						Coasters.		Total.	
	American.		British.		Other flags.					
	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.	No.	Tonnage.
1888	10	14,259	100	119,360	2	1,744	275	357,219	387	492,582
1889	5	7,739	60	75,621	4	3,976	370	357,373	439	444,709
1890	8	11,568	46	64,028	2	3,038	387	333,690	443	412,324
1891	7	9,954	95	124,837	7	7,826	393	332,374	502	474,991
1892	15	21,834	84	114,485	6	7,699	344	252,170	449	393,188
1893	19	20,585	62	94,108	3	3,528	251	188,107	335	306,328
1894	22	17,239	69	114,102	9	14,470	190	206,005	290	350,816

OUTWARD FROM PORTLAND AND ASTORIA.

1888	10	13,816	100	122,228	3	3,470	278	356,747	391	496,261
1889	5	7,104	62	77,842	4	3,976	373	363,452	444	451,374
1890	9	14,155	51	71,679	2	3,038	384	334,225	446	423,115
1891	7	10,849	73	94,490	6	6,619	381	331,963	467	443,921
1892	12	18,165	99	130,405	6	7,332	351	252,734	468	408,636
1893	17	23,046	64	96,658	5	6,397	225	182,076	311	308,177
1894	25	19,244	68	109,893	9	9,703	144	159,227	246	298,067

U U 2.

IMPROVEMENT OF COLUMBIA AND LOWER WILLAMETTE RIVERS, BELOW PORTLAND, OREGON.

The present project, adopted in 1891, for the improvement of these rivers from Portland to the sea, which includes 12 miles of the Willamette River and 98 miles of the Columbia River, contemplates securing and maintaining a navigable channel having a low-water depth of 25 feet. The original project, that of 1877, had for its object a channel 20 feet in depth. The original depth in the shoalest places was from 10 to 15 feet at low water, and previous to the adoption of this project the money appropriated and allotted was expended in dredging these shoals.

The project of 1877 included contraction works or dikes, bank revetment, closing sloughs, and auxiliary channels or chutes, as well as dredging. Under this project works were constructed in the Willamette River at Swan Island Chute, Willamette Slough, along the left bank of the river to the Columbia River, and also at other sloughs and channels at the junction of the Willamette and Columbia rivers. Works were placed in the Columbia River at St. Helens, Burke Slough, and Martin Slough. The results of these works, aided by the dredging had in 1891, attained a depth of 19 feet.

The present project proposes by the erection of other dikes and by dredging to gain an additional depth of 6 feet, or 25 feet at low water. Dikes have been built at St. Johns and Post-Office Bar in the Willamette River and at Walkers Island and Cathlamet Bay or Snag Island in the Columbia River. The dike at St. Helens has also been extended, and a dike has been built at Martins Island Bar. At the last two places mentioned the work has been done by the United States. At the others the Port of Portland, in furtherance of the general idea of the project, constructed the works without expense to the Government.

WORK DONE DURING THE FISCAL YEAR ENDING JUNE 30, 1895.

The operations during last year principally were confined to dredging, to aid in creating and maintaining channels of the depth required by the project, and removing certain new shoals from deposit during the extreme high water of 1894. The dam behind Martins Island was also extended and repaired where necessary.

Early in August, while the high water was receding, an examination of the rivers was made between Portland and Astoria to ascertain the condition of the works of improvement and the channels in their vicinity. In the Willamette River a least depth of from 17 to 19 feet at low water was found upon Swan Island Bar, on the bar above St. Johns, and on Post-Office Bar; the maintenance of the channel in the last two places is assisted by dikes, and these latter were in good condition. In the Columbia River the channel at St. Helens showed a least depth of 24 feet at low water, which was an improvement upon former soundings, and the dike was in good condition. A depth of 20 feet at low water, or an increase of 2 feet in depth, was observed in the Martins Island Channel and the dike was in good order, but the dam behind this island required extension and repair to prevent its being cut off from the island by the eddy formed behind the dam during high waters. The Walkers Island Channel had preserved its full depth of 22 feet at low water, but a new channel was discovered below this island upon which there was only 16 feet. The channel at Pillar Rock Shoal had diminished in depth to 19 feet, while that near Tongue Point and near the *Sylvia de Grasse* remained about the same, except that at the latter locality navigation was more difficult because the channel had diminished in width and become more crooked. Subsequently new shoals were found below Martins Island and at Hunters Point, near Kalama, upon which there was but 19 feet and 18 feet, respectively, at low water.

As soon as possible after the passage of the river and harbor act of August 17, 1894, dredging operations were begun with the hydraulic dredge *W. S. Ladd* upon the new shoal below Walkers Island, the most serious obstruction to navigation at the time. A channel was formed across this shoal 300 feet wide, 23 feet deep at low water, and 1,350 feet long. The dredge was then transferred to the shoals near Pillar Rock, and a channel 300 feet wide and 22 feet deep at low water was made across two bars in this locality which aggregated 1,900 feet in length. From this place the dredge proceeded to Post-Office Bar, which was deepened to 21 feet at low water, thence to Hunters Point Bar which was dredged to a depth of 21 feet at low water, thence to Martins Island Bar which was dredged to 22 feet at low water, and still later to the shoal in vicinity of the wreck of the *Sylvia de Grasse*, opposite Astoria. The channel at this latter place is very crooked, and its navigation, particularly at certain stages of the tide, is very difficult. Dredging at this point is with a view to afford temporary relief by straightening the channel so far as practicable. Permanent improvement can only be effected by the removal of the ledge upon which the wreck now lies, and by a large expenditure for additional dredging, and this work must await further appropriations by Congress.

The following table gives the amount of material removed at each of the places named:

Dredging Columbia and lower Willamette rivers for year ending June 30, 1895.

Month.	Willamette River, Post-Office Bar and mouth.	Columbia River.					Total.
		Hunters Point.	Martins Island Bar.	Pillar Rock Bar.	Walkers Island Bar.	Opposite Astoria.	
1894.	*Cu yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	*Cu. yds.*	
September 13 to 30	.....	.....	.....	.....	36,942	.....	36,942
October	.....	.....	.....	17,505	51,673	.....	69,178
November	.....	.....	.....	63,383	.....	.....	63,383
December	26,875	.....	.....	3,802	.....	.....	30,677
1895.							
January	33,738	.....	.....	.....	.....	.....	33,738
February	19,828	24,351	.....	.....	.....	.....	44,179
March	.....	32,879	50,326	.....	.....	.....	83,205
April	32,855	.....	.....	.....	.....	.....	32,855
June 10 to 30	.....	.....	.....	.....	.....	29,215	29,215
Total	113,296	57,230	50,326	84,690	88,615	29,215	423,372

The dredge has therefore removed 423,372 cubic yards of material from six different places during eight months. The average cost of the dredge per month has been $2,800.62, or about the same as last year, and the average cost of the dredging has been the same. During the month of March, when the dredge was employed the greater portion of the time on the bar below Martins Island, which was composed of coarse sand and particularly favorable for dredging, the amount removed was 83,205 cubic yards, at a cost of 3.4 cents per cubic yard.

Previous to the beginning of dredging with the *Ladd*, the bar below Walkers Island was so serious an obstruction to navigation that the Port of Portland undertook its removal and excavated 13,344 cubic yards of material before the *Ladd* arrived. Upon her arrival the dredge of the Port of Portland was transferred to Swan Island Channel, which was excavated to a depth of 22 feet, by the removal of 51,482 cubic yards. The funds of the Port of Portland have been expended under the same conditions as those stated in my last annual report.

The river and harbor act of 1894 provided for a survey of the "Columbia River below Tongue Point by way of the southern channel in front of Astoria." This survey has been made and the report with a project for the improvement of this channel was submitted to the Chief of Engineers, May 25, 1895. The project provided for straightening the present channel by dredging off the southern portion of the shoal separating the south channel from the middle channel, and the removal of a portion of the rock shoal upon which the wreck of the *Sylvia de Grasse* rests. The survey developed what appeared to be a channel forming diagonally across this separating shoal in front of the middle portion of Astoria.

Should the deepening of this channel continue and it become navigable for vessels of deep draft, while it would improve navigation by providing a shorter and more direct channel for commerce, the wharf interest of upper Astoria would suffer, as the present south channel would undoubtedly close up, and this portion of the water front of Astoria would be useless, unless the wharves were extended out to the new channel.

During the latter part of June an examination was again made of the channels of both rivers between Portland and Astoria to ascertain if the high water of May and June had materially diminished the

depth upon the shoals that had been dredged during the year. The examination indicated that the dredged depth had been maintained with but slight if any deterioration. This favorable result is without doubt largely due to the fact that the high water of this year only reached the height of 16.4 at Portland, a very moderate stage, and that in consequence the amount of silt and sand carried by the water was not great. Notwithstanding the permanent improvements that have been made, it is probable that in several localities dredging will be required each year to maintain the increased depth in the channels that have been formed, as the tendency of high waters, and especially of great floods, is to diminish their depth and create new shoals by the deposit of sand and silt, as was shown by the examination following the high water of last year.

It is possible that much of this accumulation from floods would eventually be removed by the currents, as the water falls, without dredging; but this would take time, and meanwhile navigation would be restricted because of insufficient depth in the channels and upon the shoals. It is therefore imperative to commence dredging as soon as possible after the water begins to fall, if the depths are to be maintained as required. These remarks apply to much of the dredging that was done last year, a large portion of which was not contemplated by the approved project, but became a necessity for commerce.

The dredging done during the past year has been carried to a greater depth than heretofore at all the localities, and it is proposed to continue increasing the depth each year until that required by the project is obtained, and in the meantime to construct such dikes and dams as may be required to assist in maintaining these channels. The commerce of this port is constantly increasing and the vessels are becoming larger and of deeper draft, and the completion of the project is required at an early date, especially now that the depth of water upon the bar at the mouth of the Columbia River has been so greatly increased.

The completion of the project for these rivers from Portland to Astoria was estimated, in 1891, to cost $772,464, and of this sum $200,000 has been appropriated by Congress.

The funds supplied by the Port of Portland have been partly expended in furtherance of the project and partly for the temporary relief of navigation and the maintenance of the channels already obtained. Heretofore the amounts supplied and expended in this manner have been considered in the money statements submitted with the annual reports, but as this seems unfair to the project, since it is likely to result in a considerable increase in the cost of the work above the original estimate, and as the expenditure of the funds of the Port of Portland are not made by the Government or its agent, these expenditures have been disregarded in preparing the money statement herewith.

It is estimated that the sum of $200,000 can be profitably expended on this improvement during the fiscal year ending June 30, 1897.

This work is in the collection districts of Willamette and Oregon. The ports of entry are Portland and Astoria, Oreg. The nearest light-house and works of defense are at the mouth of the Columbia River.

APPROPRIATIONS.

Act of—		
June 23, 1866 (lower Willamette)	$15,000	
March 2, 1867	30,000	
July 25, 1868 (allotted)	21,000	
April 10, 1869 (allotted)	13,365	
July 11, 1870	31,000	
June 10, 1872	50,000	
		$160,365

Act of—		
March 3, 1873 (lower Willamette, from Portland to the sea)	$20,000	
June 23, 1874	20,000	
March 3, 1875	20,000	
August 14, 1876	20,000	
June 18, 1878	30,000	
March 3, 1879	45,000	
		$155,000
June 14, 1880 (lower Willamette and Columbia, from Portland to the sea, including bar at the mouth of the Columbia)	45,000	
March 3, 1881	45,000	
August 2, 1882	100,000	
		190,000
July 5, 1884 (Columbia and lower Willamette rivers, below Portland, Oreg.)	100,000	
August 5, 1886	75,000	
August 11, 1888	100,000	
September 19, 1890	100,000	
July 13, 1892	150,000	
August 17, 1894	50,000	
		575,000
Total		1,080,365

Money statement.

July 1, 1894, balance unexpended	$4,754.13
Amount appropriated by act of August 17, 1894	50,000.00
	54,754.13
June 30, 1895, amount expended during fiscal year	30,088.85
July 1, 1895, balance unexpended	24,665.28
July 1, 1895, outstanding liabilities	2,405.06
July 1, 1895, balance available	22,260.22
Amount (estimated) required for completion of existing project	572,464.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	200,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	

COMMERCIAL STATISTICS.

The following statement of traffic on the Columbia and lower Willamette rivers has been compiled from reports of the various steamers and transportation companies doing business on these rivers during the calendar year 1893. It does not include tonnage carried in deep-sea vessels.

	Tons.		Tons.
Grain	127,389	Merchandise	303,982
Piles (439,500 linear feet)	6,585	Passengers (1,143,441)	71,465
Lumber (239,354,135 feet, B. M.)	359,021	Sand, rock, and gravel	117,000
Logs (106,266,786 feet, B. M.)	265,665	Shingles (2,000,000)	200
Cattle and horses (10,889)	5,445	Stone	74,482
Sheep and hogs (16,869)	1,054	Miscellaneous	5,158
Coal	5,745		
Wool	3,964	Total	1,347,155

List of steamers plying on the upper Willamette, lower Willamette, Columbia, and Cowlitz rivers, Oregon and Washington, during the calendar year 1894.

Name of vessel.	Tons.	Depth.	Name of vessel.	Tons.	Depth.
		Ft. in.			*Ft. in.*
Augusta	40.90	7 0	Louise Vaughn	21.64	6 0
Alliance	213.52	12 0	Lurline	338.38	6 0
Alice V	41.28	4 0	Maria	184.58	3 0
Argonaut	20.35	10 9	Messenger	95.41	3 0
Astorian	234.24	2 6	Mascot	199.46	3 0
Altona	189.68	2 3	Mayflower	23.90	6 0
Alarm	16.08	5 0	Modoc	337.55	5 0
Baby	6.02	.....	No Wonder	235.30	3 0
Bailey Gatzert	444.32	8 0	Northwest	301.98	1 3
Brazee	4.99	.....	N. S. Bentley	401.42	1 6
Brisk	1.05	.....	Ocean Wave	507.34	9 0
Bandorille	99.36	11 0	Occident	2.95	6 4
Bismarck	144.40	4 0	Oswego	21.43	3 6
C. M. Belshaw	8.12	5 8	Ocklahama	394.19	6 0
City of Frankfort	133.47	7 0	Olympian	1,083.40	.....
C. W. Rich	17.07	5 2	O. K	47.76	4 6
Carrie F	18.48	4 0	Oregon	1,612.28	20 0
Chilkat	106.45	7 5	Queen	23.75	6 2
Columbia	70.41	11 3	Quinnat	4.20	.....
Columbia	1,746.14	20 0	Restless	18.75	5 2
Cygnet	2.86	.....	Rowena	4.50	.....
Dispatch	13.47	.....	Pilgrim	28.46	.....
D. S. Baker	566.22	5 0	R. Miler	41.39	6 2
Dalles City	296.38	7 0	R. P. Elmore	57.24	.....
Edyth	1.37	.....	Ramona	114.14	5 0
Electric	20.03	4 7	R. R. Thompson	912.06	10 6
Elmore	467.60	.....	Sophia	4	.....
Enterprise	137.41	3 3	State of California	1,260.06	24 4
E. L. Dwyer	26.88	5 9	Sea Foam	9.77	.....
Escort No. 2	72.92	12 0	Sakana	3.84	.....
Emma Hayward	456.67	7 5	Sarah Dixon	278.84	6 5
Edith	37.01	7 6	Salem	240.81	1 8
Grey Eagle	166.82	.....	Stark St. Ferry	174.75	.....
Elwood	420.54	7 0	Stark St. Ferry No. 7	299.36	2 10
Egalite	82.38	4 0	Telephone	443.24	4 0
Eclipse	25.03	5 2	Tacoma	1,311.81	11 7
Eugene	271.88	.....	T. J. Potter	589.60	9 0
Fannie	276.41	5 0	Toledo	206.72	1 5
Feilda	3.46	.....	Three Sisters	327.33	1 1
George W. Shaver	276.15	2 4	Toiwo	6.27	4 0
Governor Newell	134.43	1 6	Tonquin	18.61	.....
Hassalo	350.85	6 0	The Portland	779.53	20 7
Hattie	2.92	.....	Undine	280.48	3 0
Hattie Bell	129.49	4 5	Vancouver	157.14	.....
Harvest Queen	697.04	6 0	Victorian	809.17	.....
Harvest Moon	56.15	1 6	Volga	48.18	.....
Hustler	129.58	7 0	Vulcan	219.72	4 0
Iralda	36.84	6 0	Wallowa	92.05	11 6
Ione	213.40	2 0	W. H. Harrison	52.86	6 8
Ilwaco	62.03	6 0	Water Witch	3.54	.....
Irma	6.15	.....	Wm. M. Hoag	431.13	1 6
Joseph Kellogg	272.12	2 2	W. S. Mason	252	.....
James B. Stevens	26.40	5 4	Wauna	3.10	.....
J. Ordway	194.74	4 0	Wenona	34.67	6 4
Kehani	85.41	4 0	Young America	42.10	4 5
La Camas	19.48	4 0			

IMPROVEMENT OF COLUMBIA RIVER BETWEEN VANCOUVER, WASHINGTON, AND MOUTH OF WILLAMETTE RIVER.

The project for the improvement of this portion of the river, adopted in 1892, provides for the construction of a dam connecting the head of Hayden Island with the Oregon shore. It was ascertained that about 36 per cent of the low-water discharge passed behind this island. The dam was designed to be built to the height of 4 feet above low water to stop the flow behind the island during the low-water stages, anticipating that by the increased current the water upon a bar in the main channel opposite the island would be deepened so that vessels drawing 20 feet or more might be able to ascend the river to Vancouver. The original depth upon this bar was 9 feet at low water.

The construction of the dam was commenced in 1892, and it all had been completed except a portion 60 feet long, next the island, when the work was submerged in the spring of 1893 by a rise in the river. It was several months before the water had subsided sufficiently to again expose the dam, and it was then found that the gap between the dam and the island had been increased during the high water to 470 feet by scour from the head of the island. The incomplete portion of the dam had also been destroyed, and the water in the gap had increased to a depth of from 30 feet to 39 feet.

In the following year the funds on hand being insufficient to close the gap and complete the work a contract was made with Robert Smith, of Portland, for materials and labor to revet the head of the island with fascines and stone and lay a sill, or foundation, across the gap to prevent further scour. Under this contract the head of the island and both sides of it for a length of 500 feet opposite the dam and 200 feet opposite the main channel of the river were thoroughly covered with ascines and stone from the top of the island to the foot of the slopes. The work was then interrupted by high water, which again covered the island and the dam. When the water had subsided at the beginning of the present year all the revetment had disappeared from the head and side of the island opposite the dam, and a considerable portion of the island had also been carried away. As this seemed to indicate the futility of attempting to further prosecute the work with the funds on hand, a supplemental agreement was made with Robert Smith, October 29, 1894, for closing the contract, which received the approval of the Secretary of War.

Of the balance ($3,547.33) remaining on hand after closing the contract with Robert Smith, $3,055.18 has been expended, with the approval of the Chief of Engineers, during the present year in deepening the main channel opposite the island by dredging to afford immediate relief to navigation. As soon as the water in the river had risen sufficiently to permit the hydraulic dredge *W. S. Ladd* to work in the channel, dredging operations were begun and a total of 103,633 cubic yards of material has been removed. The obstructions were found to consist of two bars, one opposite the middle of the island and one at the foot of the island, upon both of which there was about 9 feet at low water. The depth upon both of these bars has been increased to 13 feet at low water by the dredging, and navigation materially benefited.

This work is in the collection district of Willamette. The nearest port of entry is Portland, Oreg., 17 miles distant by water, 5 miles by land. The nearest lighthouse and works of defense are at the mouth of the Columbia River, 103 miles distant.

APPROPRIATIONS.

Act of July 13, 1892	$33,000

Money statement.

July 1, 1894, balance unexpended	$4,120.83
June 30, 1895, amount expended during fiscal year	3,361.53
July 1, 1895, balance unexpended	759.30
July 1, 1895, outstanding liabilities	267.15
July 1, 1895, balance available	492.15

COMMERCIAL STATISTICS.

The following statement of traffic on the Columbia River between the mouth of the Willamette River and Cascade Locks has been compiled from reports of the various steamers and transportation companies doing business on this part of the river during the calendar year 1894:

	Tons.		Tons.
Grain	7,473	Wool	2,690
Lumber (716,895 feet)	1,075	Merchandise	21,780
Logs (4,500,000 feet)	11,225	Passengers	5,070
Cattle and horses	9,760		
Sheep	3,706	Total	62,837
Coal	58		

U U 4.

CONSTRUCTION OF CANAL AT THE CASCADES, COLUMBIA RIVER, OREGON.

The Columbia River in passing through the Cascades Mountain range is forced into a narrow rocky gorge for a distance of 4½ miles. At the head of the gorge a rocky bar extends entirely across the river closing the channel completely and creating a fall of 24 feet, at the low-water stage of the river, in a distance of 2,500 feet. This locality is known as the Cascades. Throughout the remainder of the gorge the channel was formerly much obstructed by bowlders and projecting rocks, and the slope of the river bed was so great that rapids were formed that were only navigable at the lower stages of the river.

The project for improving this locality was adopted in 1877, modified in 1880, and again changed slightly in 1886. This contemplated the construction of a canal and lock at the Cascades and the improvement of the river channel through the rapids below the Cascades to provide a depth of 8 feet at low water. The length of the canal, including the lock, is 3,000 feet. The dimensions of the lock are, length 521 feet between hollow quoins, width 90 feet, and lift 24 feet at low water. The Cascades canal was calculated to be available for vessels at all stages of the river up to 20 feet above low water, and the general design of the work permitted, with slight modifications, the passage of boats to a stage of 42 feet above low water should it be required in the future.

The improvement of the river channel through the rapids has now been completed, and steamers ascend freely to the foot of the Cascades at all except the highest stages of the river.

Under the authority of Congress contained in the river and harbor act of July 13, 1892, a contract was made and afterwards approved under date of January 24, 1893, with J. G. & I. N. Day, for the completion of the canal and lock. This provided that as much of the Government plant as might be required for the prosecution of the work was to be turned over to the contractors, and that the amount appropriated for the work was to be earned within one year from the date of approval of the contract, or within one year from the date of the act appropriating each amount.

Subsequently the sundry civil act of March 3, 1893, provided as follows: "For improving canal at the Cascades of the Columbia River, Oregon, continuing improvement, one million two hundred and thirty-nine thousand six hundred and fifty-three dollars." This act further provided that not more than three-fourths of the appropriation should be expended during the fiscal year ending June 30, 1894.

The estimate for completing the work made in June, 1892, was $1,745,500, and the act of July 13, 1892, which appropriated $326,250, authorized the entire work to be put under contract, and limited the liability to be thus incurred to an additional sum of $1,419,250, or a total of $1,745,500, the amount of the estimate. The sundry civil act of March 3, 1893, as already stated, further appropriated $1,239,653, which, added to the $326,250, before mentioned, gave a total of $1,565,903, available for work under the contract.

The provisions of the contract in regard to payments were modified by supplemental articles of agreement, dated August 2 and approved August 16, 1893, to permit the payment of not to exceed three-fourths the contract price for nonperishable material fully prepared to be put in place. The time for earning the sums appropriated for the work, extended to March 3, 1895, by authority of the Chief of Engineers, January 16, 1894, has again been extended by the same authority to March 3, 1896.

The extreme high water, reported as submerging the work at the close of the last fiscal year, receded early in the present year and work was resumed in August. The damage done by the water was inconsiderable beyond destroying a portion of the protection wall at the lower entrance to the canal and a portion of the paving of the south slope opposite this protection wall. A detailed report of the condition of the work was submitted to the Chief of Engineers, and modifications of the project were recommended that would render the work secure, should there be a recurrence of the unprecedented high water of last year.

It having been clearly demonstrated since the improvement of the rapids below that steamers could without difficulty ascend the river to the mouth of the canal, at stages much higher than contemplated in the approved project, modifications were also submitted by which the canal could be made available for the passage of boats at all the higher stages during which it could be reached. These modifications provided for increasing the height of the banks and side walls of the work 6 feet, the construction of a protection wall on the outside of the river bank of the canal, and the formation of a second lock adjoining the first by constructing suitable walls between the upper lock gate and upper guard gate. It was recommended, on account of the importance of the matter, that the proposed modifications be submitted to a Board of Engineer Officers.

Pursuant to this recommendation, a Board was constituted by Special Orders No. 51, Headquarters Corps of Engineers, September 21, 1894, and its report, submitted under date of October 18, 1894, will be found printed in Senate Ex. Doc. No. 26, Fifty-third Congress, third session. The cost of the proposed modifications is estimated at $413,360.

It is highly important, both for the safety and the proper completion of the work, that this amount, which can be profitably expended during the fiscal year ending June 30, 1897, be made available at an early date. The canal can be open to navigation with the funds on hand, but it can not be protected so as to guard against damage by a recurrence of the high water of last year, and without the construction of the second lock there will be an average of three months each year when the canal will not be available for navigation, although during the greater portion of this period steamers can ascend the rapids below it. The work must therefore remain at the mercy of the high waters and navigation continue only partially provided for until the money is available.

This work has been under construction fifteen years, and its progress has suffered severely from the want of adequate appropriations to carry it along continuously. The first decided effort to make sufficient provision for it was the authorization of Congress in 1892 to place the completion of the work proposed in the approved project under contract. This plan had undoubtedly great advantages over that of continuing the work from year to year with inadequate appropriations and has advanced the work. The disadvantage of this method is that the work is placed in the hands of contractors whose progress may be fast or slow at will, so long as they keep within certain limits, the only alternative being either to annul the contract or to grant extensions of time, if requested. In this case two extensions of time of a year each have already been granted, and the completion of the project correspondingly delayed.

In the month of July the high water had subsided sufficiently to permit preparations being made for pumping out the canal. These preparations were completed, the canal pumped out, and operations resumed in the following month; the remainder of the year has been particularly advantageous for prosecuting the work, there having been much less than the average interruptions arising from frost, snow, and high water.

During the year 17,230.42 cubic yards of masonry, 27,050 cubic yards of concrete, and 1,159.5 square yards of paving have been laid, and 18,483 cubic yards of rock and 81,946 cubic yards of loose material have been excavated. The lower guard gates and the lower lock gates have been completed, and the upper guard gates are in place, though not entirely riveted. The material is on the ground for the upper lock gates, the only remaining pair required for the work, not in position. The vertical walls of the canal are now nearly completed below the lock, the walls of the lock are practically completed, and the vertical side walls of the canal above its upper gates are about completed except where they are interrupted by the bulkhead which closes the upper entrance. The paving of the inclined slopes above the vertical walls, forming the sides of the canal and lock, is also well advanced. In view of the exceptionally favorable weather during the year, the work accomplished is less than it should have been. Much remains to be done before the project is completed and the canal opened to navigation, but there is no reason why boats should not be passing through the canal by the end of the next fiscal year, June 30, 1896, if proper enterprise and energy are shown by the contractors.

The metal work of the gates is excellent, all parts fitting properly so far as they have been put together. This successful result is due to Capt. Edward Burr, formerly assistant in local charge of the Cascades Canal, who made the general plans and calculations and supervised the construction of the gates; to A. S. Fleet, draftsman, who prepared the detailed drawings, and to the Maryland Steel Company who exercised great care in manufacture.

Lieut. Harry Taylor, in local charge of the canal during the year, has intelligently performed his duties, which included the erection of the gates. His report which is appended contains many interesting details concerning the work.

This work is in the collection district of Willamette. The nearest port of entry is Portland, Oreg., 65 miles distant by river. The nearest light-house and works of defense are at the mouth of the Columbia River, 156 miles distant.

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1876	$90,000	August 11, 1888	$300,000
June 18, 1878	150,000	September 19, 1890	435,000
March 3, 1879	200,000	July 13, 1892	326,250
June 14, 1880	100,000	Sundry civil act approved March 3, 1893	1,239,653
March 3, 1881	100,000		
August 2, 1882	265,000	Total	3,443,403
July 5, 1884	150,000		
August 5, 1886	187,500		

Money statement.

July 1, 1894, balance unexpended		$1,233,353.38
June 30, 1895, amount expended during fiscal year		640,998.44
July 1, 1895, balance unexpended		592,354.94
July 1, 1895, outstanding liabilities	$18,462.57	
July 1, 1895, amount covered by uncompleted contracts	569,998.47	
		588,461.04
July 1, 1895, balance available		3,893.90
Amount (estimated) required for completion of existing project		413,360.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		413,360.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

MODIFICATION OF PROJECT FOR CONSTRUCTION OF CANAL AT THE CASCADES OF THE COLUMBIA RIVER.

[Printed in Senate Ex. Doc. No. 26, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., December 27, 1894.

SIR: I have the honor to acknowledge receipt of resolution of the 22d instant of the United States Senate, directing the Secretary of War "to transmit to the Senate any information he may have concerning the effect of the great flood of May and June, 1894, upon the work for the improvement of the Columbia River at the Cascades."

In reply to the reference of the above resolution to this office for report, I have the honor to submit the accompanying copy of letter of August 30, 1894, from Maj. James C. Post, Corps of Engineers, reporting damage to the work at the Cascades, with recommendations as to the modifications necessary in completing the improvement; also copy of report of October 18, 1894, of a Board of Engineers, convened by authority of the Secretary of War to consider and report upon proposed modifications of plans for the Cascades Lock and Canal, together with copy of letter of December 17,* 1894, from Maj. James C. Post, Corps of Engineers, submitting plans and estimates for the modifications in plans of the Cascades Lock and Canal, in accordance with the recommendations of the Board of Engineers above referred to.

The resolution of the Senate is herewith returned.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. DANIEL S. LAMONT,
Secretary of War.

* Omitted. Printed in Senate Ex. Doc. No. 26, Fifty-third Congress, third session.

REPORT OF MAJ. J. C. POST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., August 30, 1894.

GENERAL: The Columbia River having fallen sufficiently to uncover the submerged portion of the Cascades Lock and Canal and disclose the damage that has been done to the walls, etc., by the unprecedented high water of last June, I beg to submit the following report upon the condition of the work, with recommendations as to the modifications necessary in completing it, to avoid a recurrence of the damage, or more serious results, should the high water of this year be repeated, or should it be exceeded by a few feet.

The high water of 1876, the highest heretofore known, with a record of reference 139.7 on the upper gauge, was used in determining the height to which it was necessary to raise the upper guard gates and the side embankments of the canal to prevent them from being covered during the highest stages of the river. Accordingly, in the present plan these were carried to reference 142, a height that was supposed to provide for all probable contingencies. The embankments on both sides of the canal had been brought to this level, and, as the guard gates had not been constructed, a bulkhead was built across the upper entrance to the canal of the same height.

In June the height of the water of 1876 was exceeded by 6 feet, the river reaching reference 145.7 upon the upper gauge, and it continued above the reading of 1876 for fifteen days. Fortunately the work was still incomplete and a large force of laborers was available. These were immediately employed in raising the bulkhead and in building a dam connecting the bulkhead with the high bank on the south of the canal and a second dam to connect it with the river bank north of the canal, the latter being extended, as was necessary from time to time, downstream along the river bank. When the water reached its highest stage this protection line was about 2,000 feet long, and it was only through great exertion and by working day and night for more than a week that it was possible to keep in advance of the rising river and prevent the river from overflowing the dams, embankments, and bulkhead and rushing through the canal.

The rapid currents along the river bank swept away about $2\frac{2}{3}$ acres, or about one-third of the ground north of the canal, removing a strip of land varying in width from 150 feet opposite the middle of the canal to about 40 feet in width at its lower end. Heavy waves broke over the guard wall at the foot of the canal, submerging it for a length of about 460 feet, and partially destroying all the submerged portion but about 100 feet. As the water rose streams from the river came through the north embankment beneath the surface of the ground, and poured into the canal, breaking down the canal face of the embankment and displacing the revetment wall in several places. A powerful eddy was formed in the lower end of the canal, and this, together with the breaking of the heavy seas that came over the broken guard wall, tore down a large portion of the dry revetment wall at the lower end of the south side of the work.

The occurrence of this unusual high water makes it necessary to increase the height of the work, if the canal and its embankments are not to be submerged, should the high water of this year be repeated. That such submergence would be disastrous is evident from the experience of this year, and the fact that at no time during the extreme

high water was the fall in the river, in the length of the canal, or a distance of about one-half mile, reduced below 14 feet. Provision must therefore be made to avoid this contingency, and also to provide for a more serious one within reasonable limits, as the flood of this year, although extraordinary, may at some time be exceeded a few feet. To accomplish this it is proposed to raise the north embankment to the level of about 6 feet above the highest stage of the recent flood, or give it an additional height of 10 feet throughout its entire length. The surface of the embankment according to this plan will be at reference 152 from the head of the canal for about half its length, and the remainder will gradually slope down to reference 143 at its lower end.

The outer or river face of this embankment will require protection, and a rubble masonry revetment sloped 1 on 1 is provided for the purpose. The embankment on the south side of the canal should be raised, from a short distance above the upper guard gates to the upper lock gates, 8 or 10 feet higher than at present designed, according to the amount of filling available. Should this be but 8 feet higher, or at reference 150, in case of an emergency a small dam could be quickly erected across this portion of the high land south of it that would check the water attempting to flow over this side of the work before it covered the top of the north embankment. The upper guard gates, according to the present design, close the canal to reference 142, and had they been in place this year a sheet of water about 4 feet thick would have poured over them.

The original project for the canal contemplated the passage of vessels to the middle river at all stages up to 20 feet above low water, and a single lock was provided for the purpose. This limit was determined by what was supposed to be the ability of steamers to ascend to the canal through the rapids and lower cascades after the latter had been improved. Anticipating the possibility that a further extension of the project might be necessary, the work was so designed that a second lock could, if needed, be readily formed as the work progressed, or even at a later date, by the construction of proper walls for the portion of the canal included between the upper lock gates and the upper guard gates. In referring to the manner of completing them the Board of August, 1888, remarks:

> The Board regards it better to withhold an expression of opinion upon this question at the present time, in order that the requirements and necessities of commerce may be considered when this wall is needed as the work progresses.

The work has now sufficiently advanced to make it necessary to determine the character of the walls required for this part of the canal and additional data have been obtained that seem to warrant their construction as lock walls to provide for navigation at higher stages.

During the last two years the daily steamer from Portland, connecting at the Cascades with the middle-river steamer for The Dalles, has ascended to the canal on a rising river up to a stage of 36 feet above low water, and on a falling river the daily trips have been resumed at about the same stage of water. This being an ordinary river steamer establishes the fact beyond a doubt that the canal will be required at stages above those heretofore considered, and it should therefore be completed accordingly. The construction of the walls as proposed will provide for navigation up to 42 feet above low water on the lower gauge and permit the passage of boats at slightly higher stages of water than now required. Should more powerful boats be constructed than those now in use they could without doubt ascend at these higher stages. When the river exceeds a stage of 42 feet above low water the currents

over the rapids below the canal become too strong for steamers to ascend.

To ascertain the value of the proposed additional accommodation to commerce resulting from the construction of the second lock a table has been prepared, herewith inclosed, showing the number of days each year for the last fifteen years that the river has been between 20 feet and 42 feet above low water on the lower gauge. This table shows that the river was between these limits on an average of ninety days each year, and that therefore the second lock will extend the navigable period of the river about three months each year. During eleven of the fifteen years in question the two locks would have provided practically an all-the-year-round navigation, and during the remaining four years, in which the water was above 42 feet, navigation would have been suspended an aggregate of one hundred and fifty days, or an average of thirty-seven days each year.

With the second lock constructed the upper guard gates, which would then become the upper gates of the second lock, could be left with safety at their present height. The only care that need be taken would be to provide some means by which the height of the masonry piers supporting these gates could be temporarily increased during an emergency to prevent the water from pouring over them and striking the revetted slopes of the embankments. That passing over the gates would fall into at least 40 feet of water confined between masonry walls and would do no harm.

At the lower end of the canal, where during the higher stages of water the guard wall is submerged, it is proposed to reconstruct this wall to reference 120 a height of 6 feet above the river stage when navigation will cease, and give it additional thickness and a cross section that will allow the water to pass more freely over it. A wall of this height will afford the necessary protection for boats entering the canal during all stages that it can be used. The revetment on the south side of the canal opposite this wall will also be restored. The old revetment wall was dry laid, but it is proposed to use cement in making the repairs and also to increase the thickness of the wall to add to its strength and resistance against the action of the waves. A considerable portion of the dry wall along the canal and the dry revetment walls upon the slopes of the banks that have already been constructed require repairing. In doing this work it is proposed to use cement to add strength and stability to these walls.

Additional concrete flooring is also required in the canal both above and below the locks, above the locks on account of the springs that have developed under the side walls and below the locks to protect the bottom of the canal from scour when the locks are emptied.

Heretofore the project for completing this work has not included the construction of the necessary lock-keepers' dwellings. An estimate of the cost of these buildings is now submitted.

The accompanying tracing shows the work as it will appear when completed with the proposed modifications. The estimate of the cost of the modifications and the needed repairs is as follows, viz:

Estimate for completing second lock.

Dimension stone, 1,000 cubic yards, at $36	$36,000	
Face stone, 2,025 cubic yards, at $32	64,800	
Concrete, 10,480 cubic yards, at $6.25	65,500	
Iron, 12,600 pounds, at 10 cents	1,260	
		$167,560

Slope revetments.

River side, north embankment, 10,300 square yards facing, at $2.50 per square yard	$25,750	
Lower end, south side canal, 3,210 square yards facing, at $2.50 per square yard	8,025	
Repairing dry walls, 6,000 square yards facing, at $2.50 per square yard	15,000	
Repairing guard wall, 1,000 square yards facing, at $2.50 per square yard	2,500	
		$51,275
Additional concrete flooring for canal, 2,400 cubic yards, at $6.25 per cubic yard	15,000	
Lock keepers' dwellings, one principal and two assistant keepers	10,000	
		25,000
Total		243,835

As the proposed modifications and repairs involve material changes in the plan recommended by the Board of April, 1888, and of August, 1888, and extend the project already approved, I would respectfully request that this subject be referred to a Board of Engineer Officers for consideration.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., September 4, 1894.

Respectfully forwarded.

The request that the matter in question be referred to a Board is recommended to be granted.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

[Second indorsement.]

OFFICE CHIEF OF ENGINEERS,
U. S. ARMY,
September 10, 1894.

Respectfully submitted to the Secretary of War with recommendation that a Board of Engineer Officers be appointed to consider and report upon the question herein presented, the Board to consist of Col. G. H. Mendell, Col. Wm. P. Craighill, and Capt. W. L. Marshall, to meet at Portland, Oreg., upon the call of the senior member, and its expenses to be paid from the appropriation for the canal at the Cascades of the Columbia River.

With the sanction of the Secretary of War the order constituting the Board will be issued from this office.

H. M. ADAMS,
Acting Chief of Engineers.

[Third indorsement.]

WAR DEPARTMENT, *September 21, 1894.*

Approved as recommended by the Acting Chief of Engineers.

By order of the Secretary of War:

A. N. THOMPSON,
Acting Chief Clerk.

REPORT OF BOARD OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., October 18, 1894.

GENERAL: The Board of Engineers constituted by Special Orders, No. 51, headquarters Corps of Engineers, September 21, 1894, to consider and report upon modifications in the plans of the Cascades Lock, Columbia River, have the honor to submit the following report:

The Board assembled at the call of the senior member, at Portland, Oreg., October 15, 1894.

By request of the Board, Maj. James C. Post, Corps of Engineers, the officer in charge of the improvement of the Columbia River at the Cascades, was present at this meeting with maps and plans. After having read the questions submitted to them for consideration, which are contained in a report by Major Post to the Chief of Engineers, dated August 30, 1894, relating to the condition of the works at the Cascades Lock and Canal after the subsidence of the great flood of June, 1894, with recommendations and estimates for further work, and having received such further information as was attainable at this office, the Board adjourned for the day.

The next day, October 16, 1894, the members of the Board, accompanied by Major Post, visited the site of the Cascades Lock and Canal, and carefully examined the conditions of the work and the facts bearing upon the subject submitted to them.

These matters are—

1. The necessary modifications in the work made evident by the flood of 1894. For repair and preservation of the work.

2. The modifications in the projected improvement advisable or necessary to adapt the improvement to the requirements of navigation on the Columbia River for a prolongation of the annual period of utility of the work.

Major Post, in the report referred to by the Board, gives in detail the facts relating to these subjects, and the Board, in effect, agrees with him in his conclusions and recommendations as modified herein.

1. MODIFICATIONS DUE TO INCREASED FLOOD HEIGHT, REPAIR, AND PRESERVATION OF WORK.

As stated by Major Post, the flood of June, 1894, exceeded by 6 feet the highest recorded water level, i. e., that of 1876, which latter had been regarded in planning the height of guard gates, embankments, and other works of protection. The flood of June, 1894, overtopped these works by 3.7 feet, but, due to the energetic action of the officer in charge in superintending in person the raising and strengthening, in the face of the rising flood, the bulkheads and embankments, the actual damage to the work was almost insignificant, amounting to about 1 per cent of the cost of the work already done. The damage was practically confined to the work near the foot of the canal, and was as follows:

The protection embankment or wing on the river side at the lower entrance to the canal, and below the lower guard gate, and which had been necessarily constructed in a direction that caused a contraction of the area of discharge, but with steep slopes and of height greater than absolutely necessary, was demolished over a part of its height. The eddy around and behind the end of this wall undermined a portion of the slope wall laid against the south bank by washing out the earth of the unprotected (incomplete) banquette at the toe of the slope wall,

thereby causing a slide and breach in this wall, through which part of the earth behind was washed out.

The flood also washed away a large amount of earth and débris which had been excavated from the canal and lock pit and wasted on the north side. This accumulation of waste material had also somewhat contracted the natural area of discharge of the river. The damage here was of that negative character which makes it evidently necessary to construct certain work to protect an embankment which would be much better of less cubic contents. The flood failed to cut away the full excess, but the remainder must be held, because the action of future floods can not be otherwise limited at reasonable expense.

While the actual damage was almost insignificant, yet the flood demonstrated the necessity for the following modifications in details of the protection works, which modifications are recommended by the Board.

(*a*) The works of protection against floods, the levels of which have been based upon the flood of 1876, the highest water previous to 1894, must be raised to levels as much greater than shown on approved plans as the flood of 1894 exceeded that of 1876 in height, or so that these protection works shall be about 3 feet above the flood line of 1894.

(*b*) The protection wing at the river side of the canal below the lock should be modified so that the area of discharge of the river shall be reduced the least amount consistent with safe navigation up to the 42-foot stage above low water. The top surface of this wall should be as near as practicable parallel to the water surface at this stage, and arranged so that this work may at higher stages be submerged.

(*c*) The slope-wall protection of embankments exposed to wave wash, boils, and eddies should be cemented, to prevent the material behind them washing out. The river side of the embankment exposed to the current should be protected throughout its length by cemented slope wall up to the high-water level.

The Board is also of the opinion that the inclination of such exposed slopes should not be less than 1 verticle to $1\frac{1}{2}$ horizontal, and that all banquettes at foot of slopes should be paved with heavy stone, to prevent undermining of slopes at toe.

(*d*) The canal should be made more secure against injury by flood at the earliest practicable date by the construction of the upper guard gates to supplement or replace the present earthen bulkhead. The floor of the bay above the guard gates should be concreted before the work is put in use, to avoid scour.

2. MODIFICATIONS REQUIRED TO INCREASE NAVIGABLE CAPACITY OF THE CANAL.

The work to surmount the Cascades of the Columbia River has no counterpart. It is also without precedent in the conditions surrounding it. At its inception, and during its progress, the conditions to be met were unknown, but by observations are gradually being revealed. When the work of improvement began no records or observations existed giving information with reference to the physics and hydraulics of the Columbia River, or its capacity for navigation; nothing was known as to the phenomena accompanying the various phases of floods at the Cascades, such as the variations in the differences in level at head and foot of rapids during the progress of floods. No record existed of the heights of water at extreme stages, so essential in planning a work subject to such contingencies and dangers.

It was thought, when the improvement was first in question, that navigation within 4 miles of the foot of the great rapids was impracticable

at any stage. Later, even up to and after 1888, when the present project was adopted, it was believed that the rapids could not be advantageously navigated at stages of water greater than 20 feet above low water.

In accordance with this conviction the lock walls and gates were arranged with a view to limiting navigation by the use of gates and lock to stages up to 20 feet above low water; but the plans also provided guard gates above the lock at such distance above the upper lock gates that a second lock could be made at inconsiderable expense, to allow navigation at still higher stages than 20 feet. This second lock was held in abeyance, awaiting the development of navigation, by the improvement of the rapids below the Cascades.

Up to 1894 the extreme range between high and low water at the foot of the Upper Cascades was taken at 54 feet; the differences of water level at head and foot of the great rapids, 24 feet at low water and 14 feet at flood.

Of these supposed determined data the differences of level, as shown by the recent flood, only are maintained. The flood height is 60 feet in round numbers above low water. The rapids can be, and actually are, navigated since their improvement to the foot of the canal at the Upper Cascades, up to the 36-foot stage of water, and it is believed that it is practicable, or can easily be made practicable, to navigate the lower rapids in all stages of water below the 42-foot stage.

The completion of the work, so that navigation may be extended to the 42-foot stage of water, will add three months to the navigable period, or prolong the period of navigation from nine months to the entire year, except for an average period of 10 days each year, as shown by fifteen years' gauge records, when the water may be at a greater height than 42 feet above low water at the foot of the Cascades, or will increase the capacity of the canal nearly 33 per cent.

This result can now be accomplished, in the opinion of the Board, by connecting the upper guard gates by chamber walls with the head walls of the lock at the foot of the Cascades, thus converting the work from a single lock, with a guard gate above it, into a combined lock with two lifts and chambers, the lower of which lifts will be backed out at all stages of water exceeding 20 feet above low water.

As already stated, this latter work forms no part of the project now under contract, but in the opinion of the Board the adopted project, as far as it proposes leaving out the chamber walls between the guard gates and head of lock, will not suffice even for 20-foot navigation, because it has been clearly ascertained that a solid foundation for a stop wall to prevent injury by water cutting around the head walls of the lock can only be had at an unknown depth, which fact was not apparent when the work was put under contract.

It is further apparent that after this work is opened for navigation this second lock chamber can be constructed only by stopping navigation for one or more seasons, or by going to much greater expense to construct the walls while maintaining navigation.

By completing these walls now not only will the work be done more expeditiously and cheaply, but the season of navigation will be prolonged 33 per cent nearly, at an estimated additional cost of about 10 per cent of the total cost of the work now projected. The advantages are so great that the Board can not hesitate to recommend that the second lock chamber be completed before the work is opened to navigation, with the end and object in view to extend the utility of the locks

to all stages of water below 42 feet above low water at the foot of the upper Cascades.

While the recommendations of the Board are generally in accord with the report of Maj. James C. Post, the officer in charge of the work, who has already submitted estimates of cost, the Board feels that it has so far modified the recommendations of Major Post as to make it advisable that new estimates be presented to the Chief of Engineers, based upon the report of this Board. It is also observed by the Board that in Major Post's estimates there are no allowances of any kind for the contingencies to which this work is to an exceptionally large extent subjected, and there is no separation between the items that can be properly executed under the existing contract and such others that may require other methods of construction or supplementary agreements.

The Board therefore recommends that full and complete plans and estimates of the work indicated herein, not included in the work already contracted for, be made and submitted to the Chief of Engineers by the officer in charge of the work, due regard being given to the requirements of the existing contract for the completion of the work under the project now under execution.

Respectfully submitted.

G. H. MENDELL,
Colonel, Corps of Engineers.
WM. P. CRAIGHILL,
Colonel, Corps of Engineers.
W. L. MARSHALL,
Captain, Corps of Engineers.
Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

REPORT OF MAJ. J. C. POST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., December 17, 1894.

GENERAL: I beg to acknowledge the receipt of Department letter of the 10th ultimo, and to submit in compliance with instructions contained therein plans and estimates for the modifications in the plans of the Cascades Lock and Canal, Columbia River, in accordance with the recommendations of the Board of Engineers constituted by Special Orders, No. 51, headquarters, Corps of Engineers, September 21, 1894.

The Board divided the questions submitted to it into two parts:

First. Those pertaining to the modifications in the project for the repair and preservation of the work made evident by the flood of 1894.

Second. Those pertaining to the necessity for extending the project to accommodate navigation at higher stages than contemplated in the existing project to prolong the annual navigable period through the canal.

In regard to the modifications proposed for the repair and preservation, the Board recommends that the works of protection against floods be raised to a height as much greater than the flood level of 1894 as the height proposed in the existing project was above the level of the flood of 1876, the highest flood heretofore known. This requires that the top of these works be carried to reference 148, or that they be made 6 feet higher than is contemplated in the existing project.

The Board further recommends that the protection wing or wall on the river side below the lock be modified so that the area of discharge of the river shall be reduced to the least amount consistent with safe navigation for all stages up to 42 feet above low water; also that the river side of the embankment should be protected by a slope wall throughout its length to high-water level and that all slope protection walls exposed to wave action, currents, boils, and eddies should be constructed with cement, and be given an inclination not less than 1 vertical to 1½ horizontal, the banquettes at the foot of these slopes to be paved with heavy stone. The Board further adds that the floor of bay above the guard gates should be concreted to avoid scour.

The existing project provides for navigation through the canal at all stages of water to 20 feet above low water. For the reasons stated the Board recommends the construction of a second lock in connection with the first to continue the use of the canal to a stage of 42 feet above low water, and increase the navigable period from nine months to practically the entire year. This is to be accomplished by constructing suitable walls connecting the upper gate masonry of the lock with the upper guard gate masonry. Walls for this portion of the canal had been omitted from the existing project pending the determination of their character by the development and requirements of navigation.

The accompanying drawings have been prepared in accordance with the recommendations of the Board, and include all the modifications proposed.

The river side of the embankment has been protected by a slope wall, and all slope protection walls that are yet to be constructed or repaired have, as far as possible, been given an inclination of 1 upon 1½, and these walls have been carried to reference 148, except on the river side of the embankment, where the wall begins at reference 148 at the upper end, and, sloping downstream, follows parallel to the high-water slope of the river to near its lower end. At the lower end this protection wall is carried only to the highest proposed navigable stage, 42 feet above low water, or to reference 114. As it is expected that this portion of the wall will be submerged whenever the water rises above this reference, it is proposed to build it solidly and give it such a shape that the seas and currents will pass over it without damage. Suitable walls for the construction of the second lock are also included.

In the estimate for the modifications, which is appended, provision is made for construction with cement of all walls that will be subject to waves, swift currents, eddies, or boils. It is also calculated to cover the floor of the canal wherever necessary with concrete 8 inches thick, both above and below the locks. There are also included in the estimate two iron stairways between the upper and lower levels on the land side of the canal and iron steps in culvert valve walls. These are needed in operating the locks and in making repairs when required. On the drawings the masonry supporting the upper guard gates is represented at the same height as contemplated in the existing project. To prevent an overflow upon the sloping side walls of the canal when the water submerges this masonry, each of the piers is provided with a movable dam which, when raised, holds the water in check until the side walls are also submerged. A movable dam has also been placed in front of the upper guard gates, which by the modifications become the upper gates of the second lock, to permit the repair of these gates should it become necessary at any time. In one of the sections shown upon the drawings these movable dams are represented in a raised

position. All these added items, which aggregate about $8,000, are considered necessary for the proper equipment of the work.

The total estimate for the additional amount required to complete the work in accordance with the new project is $413,360.

In the existing project a wing or stop wall on the river side at the head of the lock was designed in the construction to prevent the water from passing behind the lock wall from the upper pool. Careful examination has developed that this wall, on account of difficulty in obtaining proper foundation, would cost from $20,000 to $40,000, dependent upon the difficulties encountered when the excavation for its construction is made. In the new project this wall is eliminated, as the wing or stop wall at the upper guard gates, or the upper gates of the second lock with the walls of the second lock, render it unnecessary if the canal is not open to navigation before the second lock is completed. For the protection of the work, either the wing wall mentioned or the walls f the second lock must be built before navigation through the canal is attempted, and if the latter is done the additional amount required, as submitted herewith, may be reduced by the estimated cost of this wall. It might also be mentioned that the cost of the walls of the second lock would be materially increased if they are not constructed before navigation through the canal begins. If they can be undertaken now, they would go on with the other work and be completed by the time the completion of the other parts of the canal would permit its being opened for navigation, and no delay or interference with navigation would result.

In closing its report, the Board refers to the fact that in my report of August 30, 1894, submitting the new project, there was no indication as to which of the items could properly be done under the existing contract, or which would require a supplementary agreement or other methods to carry them into execution.

The act of Congress of July 13, 1892, provided for the completion of the existing project, and under this act the contract for completion of the work was made. Anything that relates to the modification of this project can not therefore be said to be authorized by Congress or comprehended in the present contract. The project authorized by Congress, briefly stated, was to complete the canal with one lock, the latter being provided with upper and lower guard gates, to accommodate navigation at all stages up to 20 feet above low water. Of the work proposed herein, only the restoration of the damaged slope walls with cement properly belongs to the present project, and it is possible to undertake this under a supplemental agreement with the contractors. The remainder of the work proposed, the river protection wall, the raising of all protection slope walls an additional height of 6 feet, and the erection of the walls of the second lock are additions to the project, for which the authority of Congress seems necessary.

At the present time the most needed part of the additional work proposed is the slope protection wall on the river side of the embankment, rendered necessary by the action of the recent high water. Without this wall the entire embankment on the north side of the canal is liable to destruction from high water, the bulkhead closing the upper entrance to the canal can not with safety be removed, and as the work progresses the damage possible from the absence of this wall is continually increasing, and this is unavoidable. I therefore earnestly recommend that provision be made for its construction at as early a date as practicable.

It might be added that the masonry supports for the upper guard gates are already nearly completed, and it is proposed to erect these gates as soon as they can be obtained.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

ESTIMATE.

Repair and preservation of existing work.

Paving outer slope of fill, including top and both sides of protection wall and berm between toe of inner slope and coping of canal wall, 25,240 cubic yards, at $5	$126,200.00	
Repairing paving on land side of canal, 2,500 cubic yards, at $5	12,500.00	
Repairing paving on land side of canal, 810 cubic yards, at $2.50	2,025.00	
Additional paving, 6,890 cubic yards, at $2.50	17,225.00	
Concrete floor in upper bay, 3,824 cubic yards, at $6.25	23,900.00	
Concrete floor in lower bay, 832 cubic yards, at $6.25	5,200.00	
Iron stairs and steps	2,190.00	
Movable dam on top of upper guard-gate masonry	2,638.00	
Movable dam above upper guard gates	3,220.00	
		$195,098.00

Modifications required to increase navigable capacity of canal.

Concrete, 11,174 cubic yards, at $6.25	$69,837.50	
Face stone, 1,982 cubic yards, at $32	63,424.00	
Dimension stone, 1,008 cubic yards, at $36	36,288.00	
Iron, 12,600 pounds, at 9 cents	1,134.00	
		170,683.50
Lock-keepers' houses		10,000.00
		375,781.50
Contingencies, expenses of engineering and inspection, about 10 per cent.		37,578.50
Total		413,360.00

REPORT OF FIRST LIEUT. HARRY TAYLOR, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Cascade Locks, Oreg., July 3, 1895

SIR: I have the honor to submit the following report of operations for "improving Columbia River at Cascades, Oregon," for the year ending June 30, 1895:

The work during the year has all been done under the terms of the contract, dated December 27, 1892, with Messrs. J. G. & I. N. Day, for the completion of the canal as authorized by the act of Congress approved July 13, 1892.

At the beginning of the year the unprecedented flood of 1894 was still on and although the water was falling it was still far above the stage at which work could be carried on in the bottom of the canal. The water continued to fall slowly and at the end of July was below the top of the temporary bulkhead put in by the contractors, just above the upper lock-gate masonry, in March, 1894. The upper level could then be pumped out and the construction of the upper guard-gate masonry commenced. After one or two unsuccessful efforts to pump out with an engine too small to do the work, a pump and engine of suitable size were finally started on July 31, and the work of cleaning up the foundation of the upper guard-gate masonry was fairly started on August 7.

The high water was followed by the most favorable fall and winter for work known for many years. The rainfall was much below the average and there was but one snowstorm of any importance. On January 2 a snowstorm occurred which stopped

all work for about a week and delayed the masonry work until nearly the end of the month. With this exception there has been practically no delay from weather.

The mild, dry winter has been followed by an unusually low high water. The lower guard gates were erected during the spring and kept the water out of the canal until May 29, thus permitting all work between the upper bulkhead and the lower guard gate to be carried on until that date. The river remained above the lower guard gate, or rather above the temporary bulkhead which had been erected upon it, only four days, but as the contractors feared that the river might rise and flood them out again if they started their pumps immediately, they did not resume pumping again until June 8, when the river was 2½ feet below the top of the bulkhead on the gate. The water was out of the upper level on June 12, and work on the upper guard gate was resumed on June 14. No attempt has yet been made to pump the water out of the lock chamber and resume work in the lower level, but the water has been kept below the upper level and work continued in this part of the canal.

EXCAVATION.

During the year excavating has been done in the lower bay from the lower bulkhead to the lower guard gate, and a trench for the south wall of the lower entrance excavated through the bulkhead to the end of the wall; a very little in the old lock chamber, from the upper lock gate to the upper bulkhead, and on the outside of the upper bulkhead.

As soon as the water was out of the upper level in August excavating was commenced at the site of the upper guard-gate masonry. The excavation at this point was fairly started on August 7, at which time two derricks were in use and two more were in use by the 9th. During the next two weeks all four derricks were kept steadily at work, and on the 19th a small part of the foundation of the south wall had been made ready for the concrete. During the remainder of August the excavation was continued, and on September 4 the foundation of the north wall was ready for concrete to be laid upon it. Excavation at this point was then stopped until after the walls were completed. During February and March the bed rock remaining between the walls of the upper guard-gate masonry was excavated to grade.

August 15 one derrick was started excavating between the upper guard gate and the upper bulkhead. The excavation in this part of the canal was continued at intervals during the year, with one or more derricks until the end when four derricks were at work. The excavation in this part of the canal had been completed to grade over about three-fourths of the area, and the remainder to within 2 to 4 feet of grade.

September 23 excavating was commenced on the outside of the upper bulkhead. The excavation in this section of the canal was at first carried on with derricks and was confined to the sides of the canal where the walls were to be laid. Trenches were thus cut from the outer ends of the walls as far back as it was deemed safe to go, and after these had been completed to grade the trenches were widened out toward the center of the canal. This excavation was carried on entirely with derricks until December, when an incline on the south side was put in operation. More or less trouble was experienced with the working of this, but practically all the excavation done on the south side was taken out by it after it was once started. The engine used was the one formerly in use by the Government at the incline on the north side of the canal near the upper lock gate, and was the common type of cable engine having a large drum and an idler drum, around which an endless cable passes. At the other inclines, which were built after this, ordinary hoisting engines of large size were used. A single cable was wound up on the drum, and this arrangement worked much more economically and with far less trouble than the special winding engine.

After the trench for the wall was made on the north side, no excavating was done on that side until the end of February. March 2 an incline on the north side was put in use.

The excavation on the outside of the upper bulkhead was continued until April 20, when the rising river flooded the pit and caused the suspension of work. At this time the excavation had been carried to grade to the outer ends of both walls and the trenches widened out so there was but a narrow core separating them. A rim of earth had also been left on the outside to keep the river out until it was 10 feet above the adjacent low-water level.

During the flood of 1894 the protection wall on the north side at the lower end of the canal was broken down and the water poured over it. This permitted much of the earth which was washed away from the outer part of the fill on the river side of the canal to come to the lower end of the canal and be dropped in the comparatively quiet water in the lower bay. This filled the lower bay to a depth of 10 feet or more. Beginning in the early part of December this material was taken out down to grade, leaving this part in the condition in which it was before the flood.

A trench was also made through the lower bulkhead to permit the south wall of the lower entrance to be built and a little excavating at the lower end of the north wall was done to permit a short extension of that to be made.

The concrete floor at the lower guard gate and lower lock gate was also cleaned of sediment to permit the erection of these gates, and several starts were made toward excavating in the lock chamber, where there is considerable sediment and from 3 to 4 feet of bed rock still to be excavated, but practically nothing was accomplished there.

The total amount of excavation during the year amounted to 81,946 cubic yards of loose material and 18,483 cubic yards of rock, distributed as follows: On the south side of the upper bulkhead 57,025 cubic yards of loose and 11,799 cubic yards of rock; between the upper bulkhead and the upper guard-gate masonry 8,441 cubic yards of loose and 3,369 cubic yards of rock; at the site of the upper lock gate 3,328 cubic yards of loose and 277 cubic yards of rock; at the site of the upper guard gate 2,812 cubic yards of loose material and 3,038 cubic yards of rock; and in the lower entrance 10,340 cubic yards of loose material. In the lower entrance some rock was also excavated, but as this was dumped within the walls of the canal no credit was given for its excavation. The loose material excavated from the lower entrance was dumped on the top of the broken-down protection wall and within the lines which will be covered by the wall when rebuilt, and this is also withheld from the estimates until it is properly removed.

MASONRY.

As soon as the excavation was sufficiently advanced, work on the upper guard-gate masonry was commenced. The first concrete was laid on the south side on August 19, and the first stone laid August 25. On the north side the first concrete was laid on September 4, and the first stone September 5. From this time until the upper guard-gate masonry was practically completed, about the end of November, nearly all the masonry work was confined to these walls.

After the upper guard-gate walls were nearly completed, preparations were made for resuming work on the portions of the lock-chamber walls and the masonry of the upper lock gate, which were unfinished at the time the work was stopped by high water in the spring of 1894.

Stone setting was resumed on the south wall at the upper lock gate November 6, and concreting November 8; on the north side stone setting was resumed on November 20 and concreting November 22. The work at the upper guard gate was given preference over that at the upper lock gate and the latter work was also delayed somewhat by the snowy weather in January, but it was nearly completed before the end of March. Since that time one gang of masons has been at work the greater part of the time completing this masonry, laying the coping on the lock-chamber wall, finishing up the upper guard-gate masonry, and laying the coping around the lower gates.

As soon as the trenches on the outside of the upper bulkhead were completed to grade, portions of the outer ends of the upper entrance walls were begun. The first piece of the north wall was started November 26, and the first piece of the south wall January 30. As fast as the bottom was cleaned up other portions were started, until a stretch of the north wall 260 feet in length and of the south wall 400 feet in length were under construction. On both sides the walls extended as far toward the river as it is intended to build them. Work was continued on both walls until the rising river caused a suspension of work at the end of April, at which time the north wall had been completed except a small part of the coping, and the south wall had been completed to the coping, of which a few stones were laid.

At the lower end of the canal the outer end of the south wall was commenced January 28, and a short piece adjoining the part of the north wall heretofore built was commenced, including the coping back to the part previously built, a length of 130 feet, and the extension of the north wall, 60 feet in length, was completed to the coping.

The 1st of May work was commenced on the riprapping above the upper guard-gate masonry on the north side of the canal and has since been continued on the north and south side. Riprapping was also commenced on the north side of the canal opposite the lock chamber with a small force in May, but work was not fairly under way on this until June 4. Since that time the work has progressed rapidly. The total amount of riprapping done amounts to 1,160 square yards, distributed as follows: Above the upper guard gate, north side, 215 square yards; south side, 108 square yards, and opposite the lock chamber, 837 square yards.

At odd times during the year the wind walls on the south side at both the upper guard gate and upper lock gate have been very nearly completed, the one on the north side at the upper lock gate partially built, and the excavation for the one on the north side at the upper guard gate partly made.

METAL WORK.

During the year all the gates and their connections, except the miter-sill plates for two sills and the main culvert valves and frames, have been received, and the lower guard gate and lower lock gate erected and swung, and the upper guard gate partially erected.

All the metal work referred to above was built under subcontract by the Maryland Steel Company, at Sparrows Point, Md. As received here, the gates were in large sections. The quoin and miter post each formed one section and the body of the gate was in as large sections as could be shipped by rail. For the lower guard gate the body of each leaf was in five sections, the lower lock gate in six sections, the upper lock gate in five sections, and the upper guard gate in seven sections.

The sections last to arrive of each leaf of the different gates were received as follows: Lower guard gate north, October; lower guard gate south, November; lower lock gate north, December; lower lock gate south, January; upper lock gate north, March; upper lock gate south, March; upper guard gate north, April; upper guard gate south, May.

No attempt was made toward pumping out the lock pit and the erection of the lower gates until late in the fall. A pump was started November 9, and the pit was free from water, and cleaning up the sediment in the vicinity of the lower gates was commenced November 18. About the time the preliminary work of cleaning up and setting the bolts to hold the metting face place carrier castings to the walls was well started, a rain storm flooded the pit and caused a delay of several days until a pump of larger capacity could be procured and set up. Then the storm in January caused a still further delay, so that it was February before the first section of any gate was in place. From that time on the work has proceeded with comparatively little delay. The water came over the lower guard gate on May 29 and caused the suspension of work on the north leaf of the upper guard gate until June 14.

The gates are of steel ,of the single-skin type, and swing freely on the pivots without the aid of rollers or flotation chambers. Each leaf has a developed length exposed to pressure of 53½ feet. The height of the lower guard gate above the miter sill is 36 feet, of the lower lock gate 46 feet, of the upper lock gate 40 feet, and of the upper guard gate 54 feet. The gates when closed form a segment of circle, the rise of miter sill being one-fifth of the span. Upon the miter and quoin posts are vertical steel plates 8 inches in width. The plates on the two miter posts close against each other, and the ones on the quoin posts close against similar plates fitted to carrier castings attached to the wall. The sill plate on the bottom of the gate fits against a metal plate on the miter sill. The entire contact around the gate is therefore of metal against metal. The pivots of the gate are eccentric as regards the ends of quoin post, so that as soon as the gate begins to open the plate on the quoin post leaves the plate on the wall. The water pressure is all transmitted to the wall through a series of horizontal girders, each one proportioned to the work it has to do, and no pressure is supposed to be carried to the miter sill.

The method of erection of all the gates has been as follows: The lower pivots were first set. The proper location of these was determined by measuring the gates as actually received and checked by comparison with the theoretical distance between the pivots. In all cases the actual measured distances have agreed almost exactly with the theoretical. The bottom pivot casting having been located, it was held at the proper level by lead washers placed underneath, allowing one-fourth of an inch or more of space between it and the stone foundation and grouted up with a thick grout of pure cement, care being taken to carefully fill the entire space underneath the casting, and the grout was also filled up around the casting level with the top. After setting enough was picked out of the hole in the center of the casting to permit the lower pintle to be inserted. The meeting face-plate carriers, which are fastened to the wall, were then placed on the bolts, which had been previously set by means of templates, and the plates attached to the carriers. The anchor box, to which the upper collar forging is attached, was then located by transits from the bottom pivots and securely fastened in place and grouted. The erection of the gate proper was then begun. The quoin post was first erected; after that the entire body of the gate was put in place, and finally the miter post. After the entire gate was thus put in place and well bolted up the miter post was given a slight predetermined inclination from the vertical along the axis of the canal toward the convex side of the gate. Riveting was then commenced and the gate thus completed, but without the diagonal braces. After all the body of the gate was thus completed the diagonal braces were gotten into position, the rivet holes drilled in them by hand drills while they were in place, and, after they were entirely riveted on, the blocking was knocked out from under the gate and the gate swung. The meeting face-plate carriers on the wall were left loose on the bolts until after the quoin post and part of the body of the gate were in place. The gate was erected with the bottom against the miter sill in the position which it will occupy when pressure is exerted against it. The meeting face-plate carrier castings on the wall

were pulled out by means of bolts fastened to them and the gate, so that the plate, which is on the castings, pressed fairly and truly against the corresponding plate on the gate. The sides of the castings were then pointed up, and the space back of the castings grouted up by pouring from the top. A space one-fourth of an inch or more was left between the castings and the wall, and a channel about an inch wide and deep cut down the center of the stone surface behind the castings to make sure of the grout finding its way the entire length. The castings were grouted from bottom to top with one pouring, and the settlement made good by pouring more grout as long as settlement showed. All grout used was made of pure cement and as thick as could be safely poured.

It was appreciated that as the entire weight of the gate is carried by the top and bottom pivots there would be some sag which would cause the miter post to drop vertically and lean toward the concave side of the gate and also from the quoin post. As the thoroughness of the construction of the gate had as much influence over this sag as any other factor anything like an accurate calculation of the amount of sag was impossible. To offset this sag somewhat, however, it was determined to give the miter post a slight inclination in the opposite direction to which the sag would occur and also to raise it slightly. The miter posts of the lower guard gate were accordingly inclined three-fourths of an inch toward the convex side of the gate before riveting was commenced. Although the sag when the blocking was knocked out appeared to be less than this, the gates when closed met at the top before they did at the bottom. As it was preferred to have them meet at the bottom first the lower lock gates were inclined 1¼ inches and the miter post raised vertically 1 inch. The gates were well blocked up, and it was not anticipated that there would be any change in the position of the miter posts during the process of riveting, but upon measuring the south leaf of the lower lock gate just before the blocking was knocked out it was found that the inclination of the miter post had been changed so that it was 2⅝ inches instead of 1¼ inches as originally set up. The sag in this leaf was much greater than in the others and so partly corrected this extra inclination. Care has been taken to avoid a repetition of this by more careful blocking and by frequently checking up the inclination during the process of riveting.

The dates upon which the different parts of the work were begun and the amount of sag in each gate are shown in the following table:

Gates.	Date of placing.			Miter post.	Riveting began in body.	Drilling began in diagonal braces.	Gate swung.	Sag of miter post (in sixteenths of inches).		
	Quoin post.	Lower section of body.	Top section of body.					Vertical drop.	From quoin post.	From concave side of gate.
Lower guard gate south.	Feb. 16..	Feb. 19..	Feb. 24..	Feb. 26..	Feb. 27..	Mar. 15 .	Mar. 30 .	9	9	10
Lower guard gate north.	Feb. 27..	Feb. 28..	Mar. 6 ..	Mar. 11 .	Mar. 11 .	Mar. 19 .	Apr. 3 ..	11	11	12
Lower lock gate north.	Apr. 1 ..	Apr. 2 ..	Apr. 5 ..	Apr. 6 ..	Apr. 9 ..	Apr. 22 .	Apr. 29 .	12	12	12
Lower lock gate south.	Apr. 21 .	Apr. 23 .	Apr. 29 .	Apr. 30 .	Apr. 30 ..	May 9...	May 15..	13	14	19
Upper guard gate north.	May 17..	May 19..	May 23..	May 26..	May 28..	June 27 .	.....	....	....	....
Upper guard gate south.	June 22 .	June 24 .	June 28 .	.....	.....	.....	.....	....	....	....
Upper lock gate north.*	.....	.....	.....	.....	.....	.....	.....	....	....	....
Upper lock gate south.*	.....	.....	.....	.....	.....	.....	.....	....	....	....

* Erection not yet begun.

NOTE.—Riveting in upper guard gate north suspended on account of high water from May 29 to June 13, both inclusive.

The gate is arranged to close against a cast steel plate fastened to the miter sill. This plate is made in segments 5 feet long, curved to fit the bottom of the gate. These segments have been placed only on the lower guard-gate sill, as there was not sufficient time to fit them to the lower lock-gate sill after the gate was swung and before the water came over the lower guard gate. These segments were not fitted until after the gate was swung, and were then fitted in the following way: The stone

sill was cut away enough to permit the segments to be placed loosely on the bolts which fastened them to the masonry. The gates were then closed tightly together and the central segments were secured one-fourth of an inch back of the sill plate on the gate. One leaf of the gate was then pushed back out of the way and the other closed in against the central segment. The other segments on that side were then wedged out against the gate and the whole length grouted. After the grout had set this leaf was opened, the nuts on the bolts screwed up and the segments thus secured. The segments on the remaining portion of the sill were then secured in the same way. When the two leaves of the gate first meet when closed, there is, therefore, an opening between the bottom of the gate and the sill, which varies from one-fourth of an inch in the center to nothing at the two ends. As the pressure comes against the gate this opening gradually closes until when the full pressure comes upon it the opening will close and (theoretically) the gate will just touch the sill.

During May and June the lower guard gate has been subjected to a severe practical test. Since April 21 the water has been against this gate and the lock chamber entirely pumped out during the greater part of that time. During May a light wooden bulkhead 3 feet in height, was built on the top of the gate. The gate was therefore subjected to a head of 39 feet at the time the water reached the top of this bulkhead yet scarcely any water came in around the gate. In fact the inside of the gate was painted when the water was over 30 feet deep on the outside. In the lower corners of the gate near the quoin posts there were one or two small sections where a few drops of water leaked through and prevented the painting. At the extreme bottom of the gate a wedge which should have been inserted between the ends of two plates, one on the quoin post and one on the body of the gate, was accidentally omitted. Through this opening a small stream of water ran, and except for this the entire amount of water passing the gate up to the time the water reached the top could have easily been bailed out with a bucket.

To the Maryland Steel Company, who built the gates, great credit is due for the accurate and thorough manner in which they are made. Not the slightest trouble has been experienced in fitting the different sections together and the erection of the gates, which might have been a slow and difficult job, has been a comparatively rapid and simple one.

The gates have all been erected by the contractors, who have used two derricks built like an ordinary house-builders' wall derrick but of a size large enough to safely lift a 30-ton piece 60 feet from the ground on which the derrick stands. The lifting has all been done by hand, the necessary power being obtained by using six sheave blocks and a compound winch. This arrangement, while being somewhat slow, has given great satisfaction as a safe and easy way of handling the gates.

Of the work in general done during the year it may be said that the different parts could, as a rule, have been commenced earlier than they were, and a larger force of men could have been at almost all times advantageously employed and the work thereby materially advanced, and much preliminary work and repairing of plant, etc., could have been done while the main work was stopped, but which were left until the work should have been actually in progress, and thus caused delay. But the work which has been accomplished has been of a satisfactory character and the contractors have uniformly shown a disposition to regard instructions as to the quality of the work required and not to allow any slighting of work by their employees. The total amount of work of the different classes accepted during the year is as shown in the following summary of the estimates submitted for the period July 1, 1894, to June 30, 1895.

Items.	Quantity.	Price per unit.	Total.
Excavation, loose ..... cubic yards..	71,606	$0.50	$35,803.00
Rock excavation ..... do....	18,483	1.35	24,952.05
Stone cut and laid:			
Granite * ..... do....	599.28	15.87½	9,513.57
Basalt dimension * ..... do....	3,365.38	9.00	30,288.42
Basalt face * ..... do....	2,293.30	8.00	18,346.40
Basalt quarry-faced * ..... do....	985.49	7.00	6,898.43
Stone laid:			
Granite or basalt ..... do....	613.55	5.00	3,067.75
Basalt quarry-faced ..... do....	1,195.72	4.00	4,782.88
Rubble masonry ..... do....	8,178	2.00	16,356.00
Paving slopes ..... square yards..	1,159.50	2.50	2,898.75
Concrete ..... cubic yards..	27,050	6.25	169,062.50
Gates * ..... pounds..	1,106,530	.03¼	35,962.22
Gate anchorages:			
Steel rods, etc.* ..... do....	26,289	.03½	920.11
Wrought-iron nuts * ..... do....	1,368	.03¼	44.46
Cast iron * ..... do....	16,117	.01¼	201.46

Items.	Quantity.	Price per unit.	Total.
Other connections:			
Cast steel * ..... pounds..	94,224	$0.01¼	$1,177.80
Steel plates, forgings, etc.* ..... do....	36,872	.03¾	1,382.70
Wrought iron * ..... do....	3,042	.03¾	114.07
Snubbing hooks ..... do....	6,347	.09	571.23
Stone cut:			
Granite † ..... cubic yards..	123 28	47.62½	5,871.21
Basalt dimension † ..... do....	1,517.37	27.00	40,968.99
Basalt face † ..... do....	817.02	24.00	19,608.48
Basalt quarry-faced † ..... do....	1,391.64	21.00	29,224.44
Gates † ..... pounds..	2,252,409	.09¾	219,609.88
Valves and frames:			
Steel plates, angles, etc.† ..... do....	61,087	.08¼	5,039.68
Forged steel † ..... do....	37,725	.09	3,395.25
Cast iron † ..... do....	14,329	.03¾	537.34
Bronze † ..... do....	72	.26¼	18.90
Gate anchorages:			
Cast iron † ..... do....	7,762	.03¾	291.07
Other connections:			
Cast steel † ..... do....	142,664	.03¾	5,349.90
Steel plates, forgings, etc.† ..... do....	72,745	.11¼	8,183.31
Wrought iron † ..... do....	8,783	.11¼	988.09
Labor	.....	.....	571.08
Total	.....	.....	702,001.92

According to the terms of a supplemental contract dated August 2, 1893, the engineer officer in charge was authorized to pay the contractors for nonperishable material prepared in advance of the time when it should be put in the work "such portion of their contract price as said engineer officer may elect, not to exceed three-fourths of said price." The items marked thus † in the above table have been included in the estimates by the authority given by the supplemental contract referred to, and the items marked thus * are included at only one-fourth the contract price, the other three-fourths having been previously paid for the material when made ready to be put in the work. The item of labor is for work done on partially prepared stone previously cut by the Government, and is the actual cost of the labor thus performed.

The regular tests of the cement used have been kept up and special tests of such other brands as could be obtained. The cement used, the Josson & Co., "Neil-on-Ruppel" brand, continued to show the same high tensile strength and uniform good qualities as heretofore.

The following table gives a summary of the meteorological and gauge record for the year:

Month.	Rainfall.	Days on which rain or snow fell.	Average temperature at 12 m.	Highest reading of gauges.		Lowest reading of gauges.	
				Head of canal.	Foot of canal.	Head of canal.	Foot of canal.
1894.							
July	.42	3	77.6	127.9	113.6	114.4	99
August	.....	.....	78.9	113.9	98.1	106.3	87.2
September	5.89	15	65.2	106.3	87.2	101.7	80.3
October	11.21	19	56.2	101.8	80.3	100.9	78.8
November	6.93	15	52.1	102.5	81.3	101.2	79
December	6.94	13	39.1	101.9	80.4	98.4	74.7
1895.							
January	12.71	18	36	101.3	79.7	97.6	74.6
February	3.46	9	46.9	101.3	79.8	97.5	73.8
March	7.35	10	50.6	101.7	80.3	99.3	76.6
April	5.34	14	59.6	109.6	92.4	101.9	80.7
May	7.91	15	62.3	118.8	104.6	109.8	82.7
June	.43	3	72.8	117.9	103.4	112.6	96.7
Total	68.59	134	58.1	.....	.....	.....	.....

Highest reading at head of canal during the year	127.9
Highest reading at foot of canal during the year	113.6
Lowest reading at head of canal during the year	97.5
Lowest reading at foot of canal during the year	73.8

NOTE.—Reading of adopted low water at head of canal is 96; reading of adopted low water at foot of canal is 72.

Very respectfully, your obedient servant,

HARRY TAYLOR,
First Lieut., Corps of Engineers.

Maj. JAMES C. POST,
Corps of Engineers, U. S. A.

COMMERCIAL STATISTICS.

Statement of traffic over the Oregon State Portage Railway at the Cascades of the Columbia River.

	1892.	1893.	1894.
Miscellaneous freight.....tons .	9,724	8.712	6,276
Passengers.....number..	6,071	6,949	6,261

During the flood of 1894 in the Columbia River large quantities of freight en route between Portland and The Dalles were hauled around the Cascades on the Washington side of the river. The amount of this traffic could not be ascertained.

U U 5.

IMPROVEMENT OF COLUMBIA RIVER AT THREE MILE RAPIDS, AND THE CONSTRUCTION AND EQUIPMENT OF A BOAT RAILWAY FROM THE FOOT OF THE DALLES RAPIDS TO THE HEAD OF CELILO FALLS.

The river and harbor act of August 11, 1888, provided for the appointment of a Board of three engineers of the United States Army to examine the obstructions to navigation in the Columbia River at The Dalles and Celilo Falls and at Three Mile and Ten Mile rapids, and report as to the feasibility and advisability of overcoming such obstructions by means of a boat railway at The Dalles and Celilo Falls, and by widening to a navigable status for large tonnage river boats the channel of said river at Three Mile and Ten Mile rapids. The Board was further required to report as to any other plan or project for removing or overcoming these obstructions to navigation which, in its judgment, was worthy of consideration. After an exhaustive study the Board submitted its report, together with plan, drawings, and estimates, which was published as House Ex. Doc. No. 64, Fifty-first Congress, first session. The plan recommended by the Board as the most feasible and convenient method of passing a large commerce over the obstructions without transshipment of cargo was the construction, on the Washington shore, of a boat railway from the foot of The Dalles Rapids to Celilo Falls, with terminal hydraulic lifts, capable of transferring boats weighing, with cargo, 600 tons.

The improvement of the Three Mile Rapids, which is about 2 miles below the lower terminus of the railway, was also included in the project. The estimated cost of the entire improvement was $2,860,356.35.

Again, in 1892, the river and harbor act of July 13 authorized the President to appoint a second Board of Engineers, to consist of seven members, of whom three were to be from civil life, to examine the obstruction to navigation in the Columbia River between The Dalles and Celilo Falls, and report such plan for overcoming and removing these obstructions as in their opinion was most feasible and best adapted to the wants of navigation. This Board submitted its report April 12, 1893 (printed in Senate Ex. Doc. No. 7, Fifty-third Congress, first session), a majority of its members being in favor of a canal on the Oregon side of the river, with terminal lifts, the cost of which it was stated "will not greatly exceed $4,000,000." Two members of the Board preferred a boat railway, with terminal lifts on the Oregon shore, to cost an estimated sum of $2,264,467, including $170,000 for improving Three Mile Rapids.

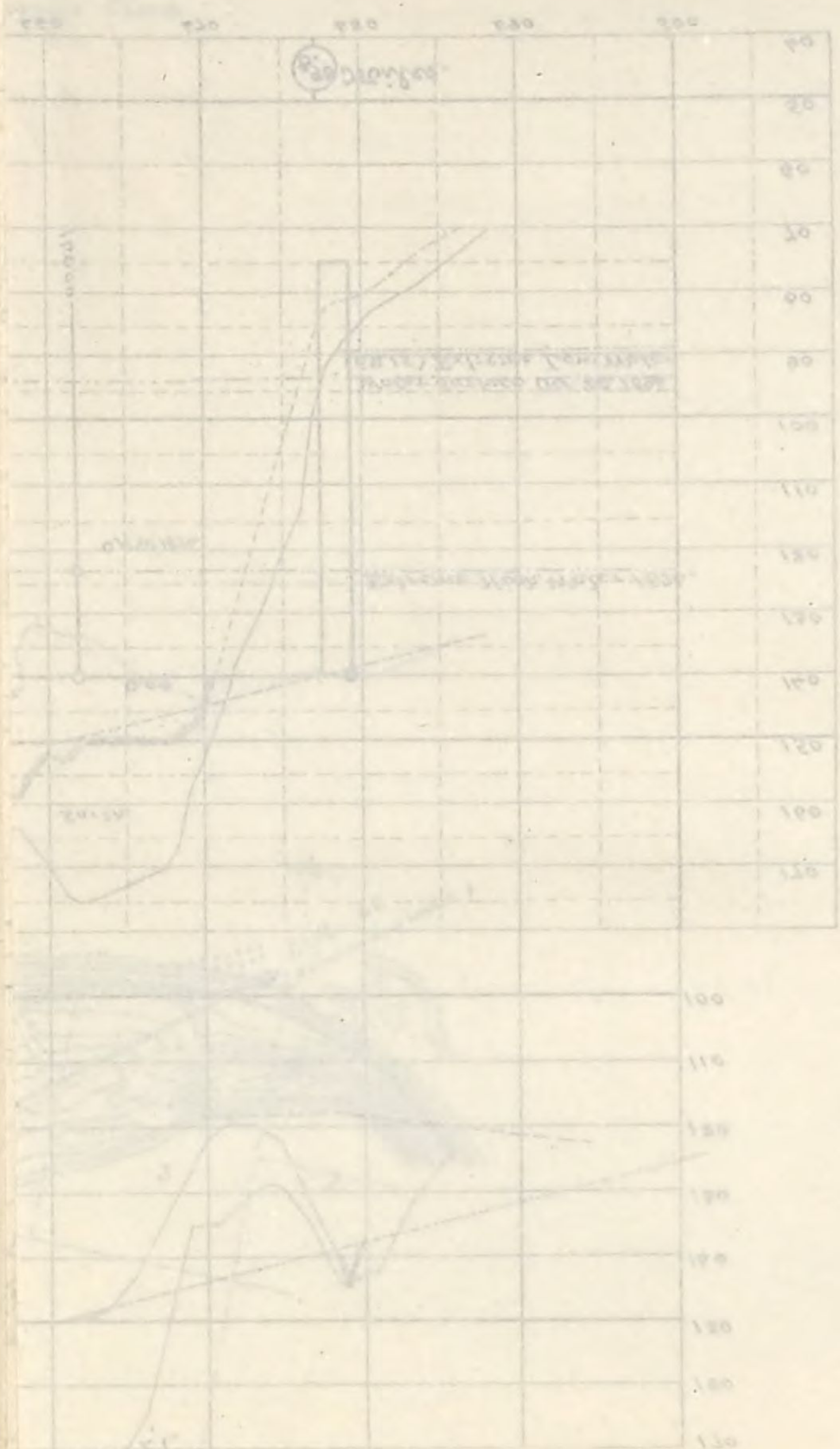
Following this report the river and harbor act of August 17, 1894, provided as follows:

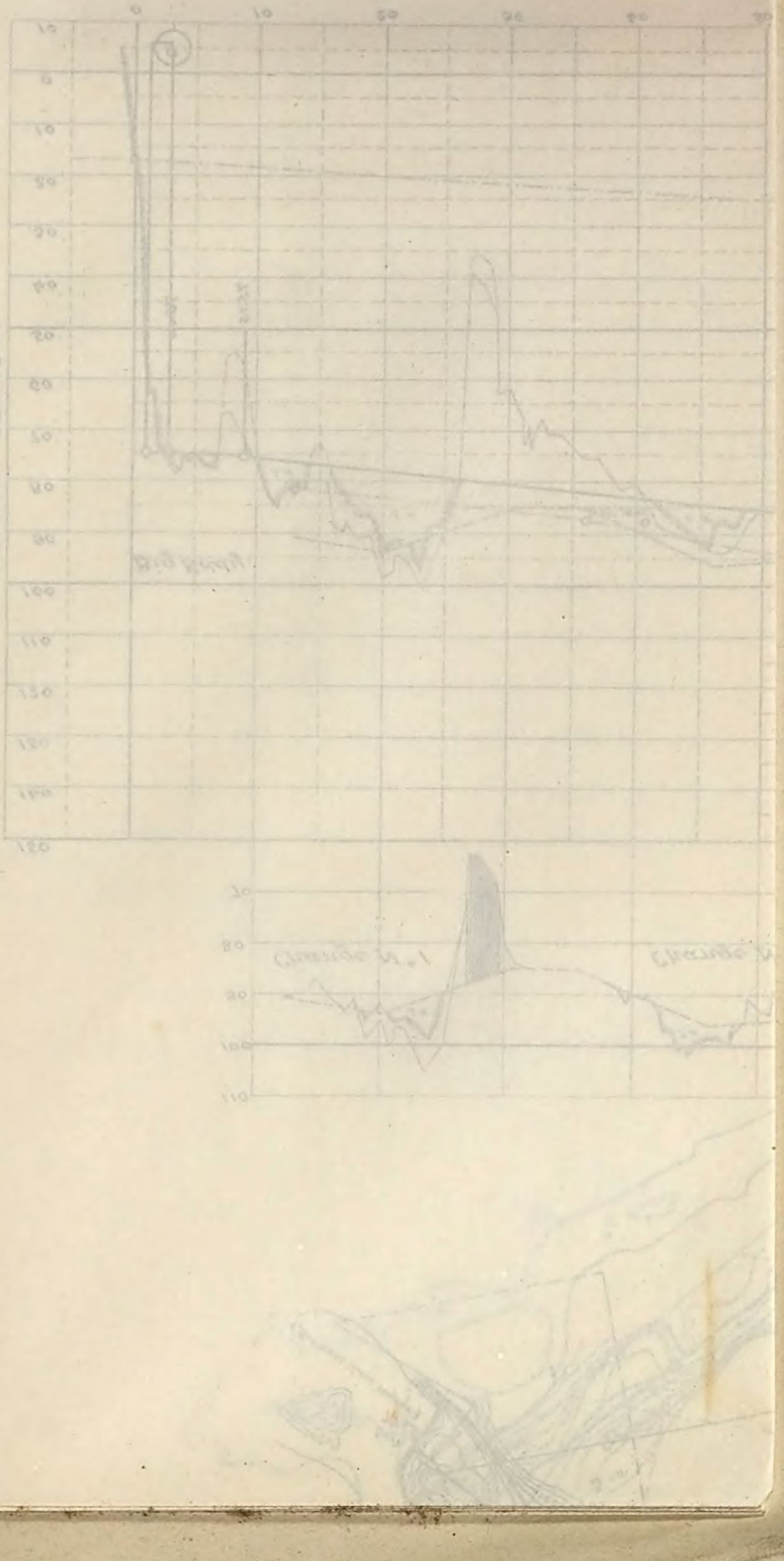
Improving Columbia River, Oregon and Washington, at Three Mile Rapids, and the construction and equipment of a boat railway from the foot of The Dalles Rapids to the head of Celilo Falls, said boat railway to be provided at each terminus with hydraulic lifts and other necessary appliances for the purpose of raising and lowering the boats on suitable cars to and from its tracks, the whole to be located, constructed, and equipped for the passage of eight boats of six hundred tons each in each direction in twelve hours, on the south side of the Columbia River, substantially in accordance with the location and plans submitted by the Board of Engineers, appointed by the President in pursuance of the provision of the act of Congress approved July thirteenth, eighteen hundred and ninety-two, and entitled "An act making appropriations for the construction, repair, and preservation of certain public works on rivers and harbors, and for other purposes," with their report, which is contained in Senate Executive Document numbered seven, Fifty-third Congress, first session, one hundred thousand dollars: *Provided*, That the Secretary of War is hereby authorized and directed to proceed to acquire, without unnecessary delay, by purchase or condemnation, in the manner and according to the conditions now prescribed by law, the necessary right of way for said boat railway and the right to the use of lands required for terminal and other facilities for said boat railway, and to expend so much of the amount hereby appropriated as may be necessary for that purpose.

In conformity with the requirements of this act the boat railway has been located. It begins at Big Eddy and terminates above Celilo Falls, and is 9 miles long. The line as located, both as to grade and curvature, is far more favorable than was supposed possible, the maximum grade being one-fourth of 1 per cent, or 13.25 feet to the mile, and the line being straight throughout, except at four localities, where there are one-half degree curves; the lifts at the upper and lower terminals at low water are 62 feet and 77 feet respectively.

Negotiations have been commenced to obtain the necessary right of way, etc., required for the boat railway, but much difficulty has been encountered, arising from the exorbitant prices demanded for the right of way by certain individuals, and the further complication that some of the land desired for the boat railway is occupied as a right of way by the Oregon Railway and Navigation Company, while the fee rests in individuals. The Oregon Railway and Navigation Company has indicated its willingness to surrender the portion of the right of way needed for the boat railway, provided it is supplied with such other right of way as will make its line continuous and the cost of changing its line is paid by the United States. In view of the position of the landowners, this proposition presents certain legal questions which have been submitted, with recommendations that they be sent to the Attorney-General for his consideration. In the meantime certain portions of the right of way, where it has been possible to make reasonable terms, will be procured and an effort will be made to induce the Oregon Railway and Navigation Company to obtain for itself the new right of way desired for its road to replace that taken for the boat railway, if it can be done at reasonable cost, the United States to reimburse the road for the sum expended for this purpose. Should this be unsuccessful, and the opinion expressed by the district attorney for Oregon, that the law does not authorize the condemnation of right of way to replace that taken from the Oregon Railway and Navigation Company, and does not authorize the transfer of land or right of way from the United States to the railway company for this purpose, be affirmed, the right of way can not be fully secured until further action of Congress.

Considerable study has been given to the details of construction during the delay in obtaining the right of way, and the estimate for the





work has been revised, and, unless unforeseen difficulties arise, it is believed that the boat railway can be thoroughly constructed and equipped and the improvement of Three Mile Rapids be made for the amount estimated by the Board of Engineers of 1892, viz, $2,264,467.

In making appropriation for the work it is recommended that the Secretary of War be authorized to enter into the necessary contracts for the entire completion of this improvement, the total liability to be thus incurred not to exceed the amount of the above estimate. It is believed that the sum of $500,000 can be profitably expended on the work during the fiscal year ending June 30, 1897.

A map showing the location of the boat railway is submitted herewith.

APPROPRIATION.

Act of August 17, 1894	$100,000

Money statement.

Amount appropriated by act of August 17, 1894	$100,000.00
June 30, 1895, amount expended during fiscal year	3,341.10
July 1, 1895, balance unexpended	96,658.90
July 1, 1895, outstanding liabilities	150.00
July 1, 1895, balance available	96,508.90
Amount (estimated) required for completion of existing project	2,264,467.00
Amount that can be profitably expended in fiscal year ending June 30, 1897	500,000.00

Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.

U U 6.

IMPROVEMENT OF WILLAMETTE RIVER ABOVE PORTLAND, AND YAMHILL RIVER, OREGON.

The project for this improvement was adopted in 1878. It contemplates the removal of snags and other obstructions and the contraction of the river in wide places, with the object of securing a navigable channel for light-draft boats from Portland to Eugene, Oreg., a distance of 172 miles. When the work was commenced the mouth of the Yamhill River, 40 miles above Portland, was the head of low-water navigation, with a draft of 2½ feet; a draft of but 1 foot could be carried above, and the channel was greatly obstructed by snags, gravel bars, etc. During recent low water boats drawing 15 inches could ascend as far as Albany, 100 miles.

The total amount appropriated since the adoption of the project is $177,000. Of this sum $3,000 was allotted by the act of July 13, 1892, to the improvement of the Yamhill River from McMinnville to its mouth. By the act of August 17, 1894, $2,000 was allotted to the Yamhill River, and $8,000 to the improvement of the Willamette River at Corvallis.

WORK DONE DURING THE PAST YEAR.

In order that navigation might not be interrupted during the low-water season, it became necessary to remove a number of snags which were causing trouble in the upper reach of the river, and the snag boat *Corvallis* was put in commission, and during the latter half of July 73

snags were removed from the channel and 16 from the banks of the river, principally at Five Islands, Lamberts Bend, and Elliotts Chute. Several large snags were also removed from the channel and banks of the river by a party with a small boat during the latter part of August at Nichols Slough and at Carys Bend.

Upon the return of the snag boat from the Cowlitz and Columbia rivers, about the middle of November, she was thoroughly repaired, and on December 4 started from Portland for Eugene, the head of navigation on the Willamette River, to begin the removal of snags, etc., from the channel. This work was continued until the beginning of February, when the work of revetting the bend of the river near Corvallis was commenced. At this locality it was feared, from the indications, that the river would open a new channel which would leave Corvallis some distance inland, and Congress in the river and harbor act of August 17, 1894, had provided that "$8,000, or so much thereof as may be necessary," should be used in protecting this place. This revetment was constructed by driving a single row of piles 9 feet between centers and about 4 feet from the bank and connecting them with two horizontal waling strips. The space behind the piles was filled with layers of brush and stone to the height of low water, after the bank had been graded to a slope of 1 on 1. The work extended a distance of 4,300 feet, and was nearly completed when a rise in the river stopped operations.

Snagging operations were resumed in the latter part of March, and were continued through April and a part of May. The snag boat was then transferred to the Yamhill, and again returned to the Willamette River the latter part of the month. From June 1 to June 10 the *Corvallis* was laid up during a rise in the river. At the latter date snagging operations were again renewed, and the river is now free from snags above Corvallis, at which place the revetment is nearly completed.

During the year a total of 764 snags were removed from the channel and 416 logs, stumps, etc., from the banks of the river. The entire river is now free from snags, except a few between Corvallis and Salem, which will be removed at an early date.

The river and harbor act of August 17, 1894, provided for a survey of "Willamette River, Oregon, from Portland to Eugene." This survey was commenced at Eugene in September, and the fieldwork has been completed to Oregon City, 12 miles above Portland. It has several times been interrupted by high water, and at present the water is too high to continue the fieldwork below Oregon City. These delays have been utilized in the preparation of the maps which are also well advanced. A report of the survey will be submitted as soon as the fieldwork and maps are completed.

YAMHILL RIVER.

From May 13 to May 23 the *Corvallis* worked on the Yamhill River between its mouth and the town of Lafayette, and removed 69 snags from the channel and 118 stumps and overhanging trees from the banks of the river between these points at a cost of $393.85.

The river and harbor act of August 17, 1894, provided for a survey of the "Yamhill River up to the town of McMinnville with a view of improving the same by locks and dams or otherwise." This survey has been made and the report was submitted March 6, 1895. This improvement is estimated to cost $69,000, and if the work is to be undertaken the entire amount should be appropriated in one sum.

ESTIMATE FOR THE FISCAL YEAR ENDING JUNE 30, 1897.

The greater part of the appropriations made for this river must of necessity be expended for the removal of snags, trees, etc., obstructing navigation, as every high water brings additional ones into the channel, which, if not taken out, would soon stop navigation by the bars they create and the obstructions they form. The river flows through an alluvial country, and its channels and banks are ever changing, largely caused by the variation in the currents due to obstructions. By the constant removal of these obstructions the channel of the river is now in better condition than ever before, and special boats are already being constructed that are calculated to reach Eugene throughout the year. The satisfactory results of this improvement warrant its continuance, and sufficient funds should be provided so that relief can be extended wherever needed.

With this end in view, and considering the economical prosecution of the work, together with the necessity for an occasional revetment for bank protection, or wing dam for concentration of the water into a single channel upon some of the bars, it is estimated that $60,000, exclusive of the amount estimated for constructing a lock and dam on the Yamhill River, can be profitably expended upon this improvement during the fiscal year ending June 30, 1897.

This river is in the collection district of Willamette. The ports of entry are Portland and Astoria, Oreg. The nearest light-house and works of defense are at the mouth of the Columbia River.

APPROPRIATIONS.

Act of—		Act of—	
March 3, 1871	$16,000	August 2, 1882	$5,000
March 3, 1873	3,000	July 5, 1884	10,000
June 23, 1874	7,500	August 5, 1886	10,000
March 3, 1875	25,000	August 11, 1888	29,000
August 14, 1876	20,000	September 19, 1890	11,000
June 18, 1878	20,000	July 13, 1892	* 30,000
March 3, 1879	12,000	August 17, 1894	† 23,000
June 14, 1880	12,000		
March 3, 1881	15,000	Total	248,500

Money statement.

July 1, 1894, balance unexpended	$3,426.25
Amount appropriated by act of August 17, 1894	23,000.00
	26,426.25
June 30, 1895, amount expended during fiscal year	14,272.28
July 1, 1895, balance unexpended	12,153.97
July 1, 1895, outstanding liabilities	790.40
July 1, 1895, balance available	11,363.57
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.	60,000.00

* Of which $3,000 was allotted to Yamhill River.
† Of which $2,000 was allotted to Yamhill.

COMMERCIAL STATISTICS.

The following statement of traffic on the Willamette River, above Portland, has been compiled from reports of the various steamers and transportation companies doing business on this part of the river, during the year ending December 31, 1894:

	Tons.		Tons.
Grain	18,590	Wool	474
Lumber (592,017 feet)	888	General merchandise	46,603
Logs (2,000 feet)	5	Passengers	3,523
Cattle and horses	341	Iron pipe	7,500
Sheep and hogs	151		
Coal	63	Total	78,138

U U 7.

IMPROVEMENT OF COWLITZ RIVER, WASHINGTON.

The Cowlitz River is a tributary of the Columbia River and flows into it from the north about 64 miles above the mouth of the Columbia. The project for the improvement of this river was adopted in 1882, and contemplated the removal of sand bars, snags, rocks, and other obstructions from the channel for 50 miles above its junction with the Columbia River. The minimum depth to Toledo, 30 miles above the mouth, prior to the commencement of the improvement, was from 12 to 14 inches at low water. The effect of the improvement has been to increase the low-water depth over this portion to 30 inches, and the season of navigation is now increased an additional month each year. To maintain this depth it is necessary after each period of high water to remove the snags and other obstructions that have drifted into the river.

The original estimate for this improvement was $5,000 for the first year and an expenditure of $2,000 each subsequent year. The total amount thus far appropriated is $25,000.

Upon examination made in August, 1894, the river was found to be seriously obstructed by snags and débris washed into the channel during the preceding high water, and between August 6 and August 18 a party provided with a small boat, the necessary tools, explosives, etc., and operating between Toledo and the mouth of the river, removed 95 snags from the channel and 14 logs and stumps from the banks, where they were liable to be carried into the channel by the next high water. A large rock which obstructed navigation at Batteau Rapids was also removed by blasting. The results of this work were quite satisfactory and the river has remained in fair navigable condition to the end of the year.

Considerable erosion of the bank having occurred in the bend just below Toledo, resulting in the formation of a wide gravel bar on the concave side of the bend and threatening to seriously impair the navigation at that point, it was decided to construct a revetment along the bank on the convex side to prevent further erosion, and to hold the channel in its present favorable position.

The construction of this revetment was begun during the last week in September and was completed during the succeeding month. The revetment, which is built of piles and brush weighted with stone, extends along the banks for a distance of 2,000 feet. The piles were driven by the U. S. snag boat *Corvallis*, and the other work of construction was performed by the crew of this boat, assisted by a force of laboring men and teamsters engaged in the neighborhood.

The piles were first driven at intervals of 8 or 9 feet along the foot of the bank, and the bank was then graded to a slope of 1 on 1. Two, and in some places, three rows of logs were then secured longitudinally, one above the other, along the inside of the stretch of piling, and the space behind this bulkhead was filled with brush ballasted with stone. Two hundred and twenty-nine piles, 500 cords of brush, and about 825 tons of rock were used in building this revetment. The cost of the revetment was $1.42 per linear foot.

Piles, rock, etc., to the value of $350 were donated by the citizens for use on the work, and the appropriation made by Congress was relieved to this extent.

Twelve piles were also driven opposite Toledo and ten at Keegans Bar for bank protection at these points.

The funds remaining available will probably suffice for removing obstructions during the year ending June 30, 1896. It is estimated that the sum of $3,000 can be profitably expended on this improvement during the fiscal year ending June 30, 1897.

APPROPRIATIONS.

Act of—		Act of—	
June 14, 1880	$2,000	September 19, 1890	$8,000
March 3, 1881	1,000	July 13, 1892	3,000
August 2, 1882	1,000	August 17, 1894	3,000
July 5, 1884	2,000		
August 5, 1886	2,000	Total	25,000
August 11, 1888	3,000		

Money statement.

July 1, 1894, balance unexpended	$1,620.39
Amount appropriated by act of August 17, 1894	3,000.00
	4,620.39
June 30, 1895, amount expended during fiscal year	3,287.47
July 1, 1895, balance unexpended	1,332.92
Amount that can be profitably expended in fiscal year ending June 30, 1897 Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867, and of sundry civil act of March 3, 1893.	3,000.00

COMMERCIAL STATISTICS.

The following statement of traffic on the Cowlitz River has been compiled from reports of the various steamers and transportation companies doing business on this river during the year ending December 31, 1894:

	Tons.		Tons.
Grain	9,251	General merchandise	4,154
Lumber (500,000 feet)	750	Passengers	1,554
Cattle and horses	213		
Sheep	1	Total	17,923
Shingles	2,000		

U U 8.

IMPROVEMENT OF YOUNGS AND KLASKUINE RIVERS, OREGON.

Youngs River is one of the southern tributaries of the Columbia and joins this river at Youngs Bay, near its mouth; the Klaskuine empties into Youngs River 6 miles above Youngs Bay. The project contemplated the removal of obstructions in Youngs River for a distance of 7

miles above its mouth, and in the Klaskuine from its mouth to Kamm's Wharf, a distance of 2 miles.

The estimated cost of this improvement was $1,600, and this sum was appropriated by the river and harbor act of September 19, 1890.

During the fiscal year ending June 30, 1891, the sum of $1,206.79 was expended on this improvement securing a channel depth of 7 feet at high tide to the limits named. No further appropriation is recommended.

Money statement.

July 1, 1894, balance unexpended	$377.53
July 1, 1895, balance unexpended	377.53

U U 9.

GAUGING WATERS OF COLUMBIA RIVER, OREGON AND WASHINGTON.

The self-registering gauge at Astoria, Oreg., has been maintained during the year and the daily readings of this gauge have been publicly exhibited in Astoria for the benefit of commerce.

The balance available ($592) will suffice for maintaining the gauge to June 30, 1896, and it is estimated that $1,000 can be profitably expended in gauging the waters of the Columbia River for the fiscal year ending June 30, 1897.

APPROPRIATIONS.

Act of—	
August 2, 1882	$500
July 5, 1884	1,000
August 5, 1886	1,000
August 11, 1888	2,500
August 17, 1894	1,000
Total	6,000

Money statement.

Amount appropriated by act of August 17, 1894		$1,000.00
June 30, 1895, amount expended during fiscal year		351.00
July 1, 1895, balance unexpended		649.00
July 1, 1895, outstanding liabilities		57.00
July 1, 1895, balance available		592.00
Amount that can be profitably expended in fiscal year ending June 30, 1897		1,000.00
Submitted in compliance with requirements of sections 2 of river and harbor acts of 1866 and 1867 and of sundry civil act of March 3, 1893.		

U U 10.

PRELIMINARY EXAMINATION OF CLATSKANIE RIVER, OREGON, FROM MOUTH TO TOWN OF CLATSKANIE.

[Printed in House Ex. Doc. No. 330, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 18, 1895.

SIR: I have the honor to submit the accompanying copy of report of February 7, 1895, by Maj. James C. Post, Corps of Engineers, of the results of a preliminary examination of Clatskanie River, Oregon, from

its mouth to the town of Clatskanie, made to comply with the provisions of the river and harbor act of August 17, 1894.

Major Post is of opinion that the river is worthy of improvement by the General Government, and he states that it is believed that sufficient data has been obtained for the preparation of an estimate of the cost of the work proposed.

The opinion of Major Post is concurred in by Col. G. H. Mendell, Corps of Engineers, division engineer, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. J. C. POST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., February 7, 1895.

GENERAL: I have the honor to submit the following report of the preliminary examination of the Clatskanie River, Oregon, from its mouth to the town of Clatskanie, made in compliance with instructions contained in Department letter of August 20, 1894.

The Clatskanie River rises in the Nehalem Mountains and flows in a northerly direction to the Columbia River, which it enters 60 miles below the mouth of the Willamette River, or about 70 miles below the city of Portland, through what is known as Clatskanie or Beaver Slough and Wallace Slough.

From Clatskanie City to Beaver Slough, a distance of about 1 mile in an air line and 3 miles by water, the river winds in a tortuous course through a low marsh, which is annually submerged by the high water of the Columbia River. Its width varies from 50 to 60 feet, and the channel contains throughout its length a depth of from 5 to 6 feet at low water, except upon four short bars of an aggregate length of 600 feet, where there is but 2 to 3 feet at low water. The tide has an average rise and fall of 3 feet at Clatskanie City. The principal obstructions to navigation are the abrupt bends in the channel, which make the passage of steamers to Clatskanie City very difficult.

The improvements desired are such as would relieve navigation at the worst of the bends, three in number, and establish a channel to Clatskanie City having a depth of 4 feet at low water and a bottom width of 45 feet. The former can readily be avoided by making straight cuts through the marsh, which averages about 5 feet above low water. The first of these cuts would be 1,300 feet long, the second 450 feet, and the third 1,200 feet, making a total length of 2,950 feet, or about three-fifths of a mile of new channel to be opened to the required depth and width. One of these cuts would also avoid a portion of the shoals already mentioned and diminish the amount of dredging to be done in the present channel to increase the depth to 4 feet at low water. In addition to the dredging it is probable that some snags would also require removing.

During the year 1893 two steamers navigated this river, carrying 4,000 passengers and 5,000 tons of merchandise, 5,000,000 feet of lumber (cedar and fir), and 5,000,000 cedar shingles. In addition to these, so far as could be ascertained, about 30,000,000 linear feet of logs were floated out in rafts and 14,000,000 feet of sawed lumber and 18,500,000

shingles were shipped on scows and flatboats. The total value of the commerce of this river for the year 1893, assuming the amounts given to be fairly correct, is therefore, at a low estimate, $500,000.

Considering the amount of commerce involved and the limited extent of the improvement desired, this river, in my opinion, is worthy of improvement by the General Government from its mouth to Clatskanie City.

It is believed that sufficient data were obtained when the preliminary survey was made for the preparation of an estimate of the cost of the work. A survey of the river would cost $400.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., February 11, 1895.

Respectfully forwarded to the Chief of Engineers.

For reasons given, the Clatskanie River, Oregon, is considered to be worthy of improvement.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

U U 11.

PRELIMINARY EXAMINATION OF TUALITON RIVER TO HILLSBORO, OREGON, AND TO THE HEAD OF NAVIGATION.

[Printed in House Ex. Doc. No. 344, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 26, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated the 13th instant, by Maj. J. C. Post, Corps of Engineers, of the results of a preliminary examination of Tauliton River to Hillsboro and to the head of navigation, Oregon, made to comply with the provisions of the river and harbor act of August 17, 1894.

Major Post states that he does not deem this river worthy of improvement by the General Government, which opinion is concurred in by Col. G. H. Mendell, Corps of Engineers, division engineer, and by this office.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. J. C. POST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., February 13, 1895.

GENERAL: I have the honor to submit the following report of the preliminary examination of the "Tualiton River to Hillsboro and to the head of navigation," made in compliance with instructions contained in Department letter of August 20, 1894.

The Tualiton River rises in the Coast Range of mountains and, flowing in a southeasterly direction, empties into the Willamette River about 14 miles above Portland. It drains an area of about 550 square miles, which includes one of the best agricultural districts in Oregon, known as the Tualiton Plains. The river is subject to freshets in the early spring and the water sometimes rises 25 feet at Hillsboro, flooding a large portion of the surrounding country.

The examination was commenced at Gaston, the junction of the river with what was formerly a shallow lake of considerable area and known as Wapato Lake. Half a mile below the lake a canal 1½ miles long has been opened by the property owners in the vicinity which straightens the river and drains the bed of the lake for agricultural purposes. The river flows in a tortuous channel throughout its length, and from the canal to Hillsboro, a distance of 16 miles, varies in width from 20 feet to 60 feet. From Hillsboro to the mouth, an additional distance of about 40 miles, the width increases to 200 feet. The channel is obstructed by snags and log jams, which were found in many places, two private dams, and rapids which extend from the second of the dams to the mouth of the river, a distance of 1½ miles.

The first of the dams, 14 feet in height, is located at Dilley, 2 miles below the canal, and was built by a flour-mill company for milling purposes. The second dam, 4 feet in height, was built by the Oswego Iron and Steel Company. Between Hillsboro and this dam, 38 miles, the channel is nowhere less than 3 feet in depth at low water, and in this portion of the river three small steamers, the largest being 60 feet long and 15 feet wide, with a draft of 2 feet, are operated by the steel company and used for towing logs, carrying freight, etc. In higher stages of water and when the river has been cleared of log jams the steamers have extended their trips to Cornelius, 8 miles above Hillsboro. Below the second dam the fall in the river at the rapids in about 30 feet to the Willamette River. These rapids are impassable for steamers, and any project contemplating the improvement of this river must include the construction of a canal and locks for passing them, if a navigable connection is made between the two rivers. The river is further obstructed by fourteen bridges which cross it at various points with single spans at heights varying from 10 feet to 30 feet above low water.

The commerce of the valley is computed to amount to 6,000 tons of produce annually, with a return commerce from Portland of about 3,000 tons, or a total of 9,000 tons. On account of the large expenditure required to improve this river, and the relatively small amount of commerce to be benefited, I do not deem this river worthy of improvement by the General Government.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., February 18, 1895.

Respectfully forwarded to the Chief of Engineers.

For reasons herein given the Tualiton river is regarded as not worthy of improvement by the General Government.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

U U 12.

PRELIMINARY EXAMINATION OF LEWIS RIVER, WASHINGTON, FROM LA CENTER TO ITS MOUTH, WITH A VIEW OF DEEPENING THE CHANNEL AND IMPROVING THE NAVIGATION.

[Printed in House Ex. Doc. No. 331, Fifty-third Congress, third session.]

OFFICE OF THE CHIEF OF ENGINEERS,
UNITED STATES ARMY,
Washington, D. C., February 18, 1895.

SIR: I have the honor to submit the accompanying copy of report, dated February 8, 1895, by Maj. J. C. Post, Corps of Engineers, of the results of a preliminary examination of Lewis River, Washington, from La Center to its mouth, with a view of deepening the channel and improving the navigation, made to comply with the provisions of the river and harbor act of August 17, 1894.

Major Post states that it would be a great benefit to navigation if the depth on the shoals between the forks and La Center could be increased to 2 feet at low water, or to the same depth as exists upon the shoals in the river below the junction; and it is his opinion, concurred in by Col. G. H. Mendell, Corps of Engineers, division engineer, and by this office, that this locality is worthy of improvement to this extent by the General Government.

It is estimated that a survey of the river from the Columbia River to La Center, for preparation of project and estimate of cost of improvement, would cost $600.

Very respectfully, your obedient servant,

THOS. LINCOLN CASEY,
Brig. Gen., Chief of Engineers.

Hon. D. S. LAMONT,
Secretary of War.

REPORT OF MAJ. J. C. POST, CORPS OF ENGINEERS.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., February 8, 1895.

GENERAL: I have the honor to submit the following report of the preliminary examination of "Lewis River," Washington, "from La Center to its mouth, with a view to deepening the channel and improving navigation," made in compliance with instructions contained in your letter of August 20, 1894.

The Lewis River flows into the Columbia River about 14 miles below the mouth of the Willamette River and 25 miles from the city of Portland.

About 3½ miles above its junction with the Columbia River the river divides into two branches, known as the North and East forks. La Center is situated upon the East Fork, 7 miles by water from the Columbia River. The river from the Columbia to the junction of the forks is from 400 feet to 500 feet wide, and the East Fork, from the junction to La Center, from 150 feet to 250 feet wide. The average rise and fall of the tide is 3 feet at the mouth of the river and 14 inches at La Center.

With the exception of three shoals, aggregating a length of 1,700 feet, upon which there is 2 feet at low water, the channel from the mouth of the river to the junction of the forks contains a depth throughout of 6 feet at low water at a low stage of river. From the junction to La Center the channel of the East Fork is obstructed by several shoals upon which there is only 9 inches to 12 inches of water at low water. Except at these localities the channel is 4½ feet deep at low water to La Center.

At the time the examination was made the river was at a low stage, and the regular river steamer could only ascend to the junction of the forks. At this point a transfer was made to a light-draft steamer which went up the East Fork a distance of 1½ miles, when a second transfer was made to a barge or flatboat which was towed by a rope from the river bank to La Center and delivered the freight and passengers.

The commerce of the river consists of general merchandise, agricultural produce, such as grain, hay, etc., and lumber, wood, piles, and, together with the passengers carried, was valued at $119,000 for the year 1893. The surrounding country is good farming land, and it is believed that with increased transportation facilities there would be a substantial addition to the yearly amount of commerce.

From the description of the river to La Center it will be observed that there is a low-water depth of 2 feet at a low stage to the forks, and that from there to La Center the depth on the shoals is much less. It would be a great benefit to navigation if the depth on these shoals could be increased to 2 feet at low water or to the same depth as exists upon the shoals in the river below the junction. This could be effected at a small cost and would greatly facilitate transportation by avoiding the transfers that are now necessary at low water.

While the amount of commerce of this river, judging by the estimate for 1893, is not great, the promise of its material increase at a small cost is so favorable that in my opinion this river is worthy of improvement by the General Government to the extent suggested. It is estimated that a survey of the river from the Columbia River to La Center would cost $600.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., February 11, 1895.

Respectfully forwarded to the Chief of Engineers.
For reasons given Lewis River is regarded as worthy of improvement.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

U U 13.

SURVEY OF YAMHILL RIVER, OREGON, UP TO THE TOWN OF McMINNVILLE WITH A VIEW OF IMPROVING THE SAME BY LOCKS AND DAMS OR OTHERWISE.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., March 6, 1895.

GENERAL: In compliance with instructions contained in Department letter of September 25, 1894, assigning to my charge the survey of the "Yamhill River up to McMinnville with a view of improving the same by locks or dams or otherwise," provided for by section 12 of the river and harbor act of August 17, 1894, I beg to submit the following report:

The river and harbor act of March 3, 1873, contained a provision for a preliminary examination and survey of the Yamhill River, and a detailed report of the results was submitted by Maj. N. Michler, Corps of Engineers, December 21, 1874. It was stated in the report that the removal of snags and the opening of short cuts through four rock bars was all that was needed by navigation at the time. The estimate for the improvement of the river provided for the removal of the obstructions and also included the cost of constructing a lock and dam to be located at the mouth of the river and designed to enable boats with a draft of 2½ feet to ascend the river uninterruptedly throughout the year to within about 4½ miles by river, or 2 miles by land, of McMinnville.

In 1890 the river and harbor act of that year provided for a preliminary examination of "the Yamhill River from its mouth to McMinnville with a view to improving the same by removing snags and other obstructions." This examination was also made and was followed by a survey and a report by Maj. T. H. Handbury, Corps of Engineers, then in charge, under date of July 18, 1891. In this report it was estimated that $3,000 could be profitably expended in removing trees, snags, sunken logs, stumps, etc., from the river. In the act of July 13, 1892, Congress provided the $3,000 recommended and also directed that a preliminary examination be made of "the Yamhill River from its mouth to McMinnville for slack-water navigation by lock and dam at Lafayette." This examination was also assigned to Major Handbury, who reported adversely upon this method of improvement, stating that the present and prospective commerce of the river did not warrant so large an expenditure by the Government.

The appropriation, $3,000, has been expended in removing the obstructions, and last spring a steamer ascended the river to McMinnville for the first time in fourteen years, and has continued her trips since whenever there has been sufficient water. The river from its mouth to McMinnville is narrow and tortuous, flowing generally between steep clay banks, a large portion of which are covered with trees of various sizes. The rises in the river, which occur at least once a year, sometimes from heavy rains and the melting of snow at its source, but more often from the backwater of the Willamette River, saturate the banks, causing land slides as the water recedes, which sometimes completely close the channel. Generally the rises in the Yamhill are more or less a combination of floods at the headwaters and the backwater from the Willamette. So far as can be ascertained a flood at the headwaters without backwater will not cause a rise of more than 12 feet above low water at McMinnville, while backwater has been known to reach the height of 52 above low water at the same locality.

From the character of the river there seems to be no other method of improving it for navigable purposes than by removing such obstruc-

tions as result from landslides, floating trees, etc., or by the erection of a lock and dam at a suitable location to afford slack water of sufficient depth at low water to pass over the shoals and rapids which during low stages prevent navigation. As already stated, an estimate was made for the removal of snags, etc., and an appropriation for the purpose was made. The recent act directing the new survey also makes a second appropriation for this purpose. Considering this fact and the phraseology of the act concerning the survey, it appears to be the intention of Congress that an estimate of the cost of slack-water navigation to McMinnville should now be submitted. It should be understood, however, that the obstructions similar to those already removed will continue to form even if the lock and dam are constructed, and that to keep the new channel free from fallen trees, snags, stumps, etc., a yearly expenditure will be required.

The surveys of 1874 and 1891 supplied sufficient information for the determination of all the physical features of the river, and it only remained to obtain such additional data as was necessary for the selection of the site for the lock and dam best adapted for accomplishing the improvement desired. Beginning at the mouth of the river and passing up stream, the first obstruction to low-water navigation is a short gravel bar near the junction of the two rivers which interferes with the passage of steamers at extreme low water. The second obstruction is a ledge of sandstone lying in the bed of the river near Martins Landing about 6 miles from the junction. About a mile above this ledge the rapids of the Yamhill begin, and these extend a little more than a mile and terminate with a low fall. Above the fall the river is free from shoals or bars until within a short distance of McMinnville, where several rock bars are found.

The following table, taken from the report of Maj. N. Michler, Corps of Engineers, before mentioned, gives the fall in the various sections of the river:

Fall of river at extreme low water.

	Difference of levels in feet.	
From McMinnville (county bridge) to station 23 on map (2 miles east of the town)	3.313	.....
From McMinnville to Lafayette, above fall	.426	3.739
From McMinnville to Lafayette, below fall (fall 3.627 feet)	3.627	7.366
From McMinnville to foot of rapids below Lafayette Rapids (fall 5.195 feet)	5.195	12.561
From McMinnville to Dayton	.512	13.573
From McMinnville to mouth of Yamhill (junction of Willamette)	.5	13.573

The gravel bar near the junction of the two rivers being but a slight obstruction to navigation, and it also being possible to excavate a channel of sufficient size through the sandstone ledge at Martins Landing at small cost, it was considered that the most suitable location for the lock and dam would be at or near the foot of the rapids. After running a line of check levels from above the falls at La Fayette to the foot of the rapids, carefully examining the sites available, making borings, etc., a point about 900 feet below the foot of the rapids has been selected where the dam and the greater portion of the lock can be given a rock foundation, and the dam have sufficient length to permit a ready outflow of a head rise in the river.

In the plan submitted the dam and abutment are composed of timber cribs filled with stone and properly sheeted with heavy plank. The dam is 114 feet long with its crest 15.3 feet above the level of the low water in the river at the time the survey was made, which is believed

to be about average low water. This height of dam will give a depth of at least 4 feet at low water to McMinnville at the county bridge, except upon a reef of rocks a short distance below the bridge which will be submerged but little more than 2 feet. This reef can be removed without difficulty if navigation should require the extension of the pool to the bridge. The depth of 4 feet is ample for all steamers navigating the upper Willamette River, which rarely draw more than 3 feet. The dimensions of these steamers are limited by the locks at the Willamette Falls, Oregon City, about 12 miles above Portland, which are 40 feet wide and 210 feet long between quoin posts. The lock walls for the Yamhill are designed to be monoliths of concrete, with the chamber 40 feet wide and 210 feet long, between quoins, to accommodate boats of the same size as those at Oregon City. The guard of the lock, or the height of the walls above the crest of the dam, is calculated at 4.7 feet, which is deemed sufficient for this locality where the rises in the river are generally caused by back water. As soon as the lock walls are submerged by the back water, boats can pass over the dam in safety. There will therefore be no interruptions to navigation throughout the year, except those due to floods in the head waters of the river, when there is little or no back water from the Willamette River, a condition which is usually of short duration.

The following is an estimate of the cost of the lock and dam and other necessary work for making this river navigable to McMinnville for a draft of 3½ feet during the entire year:

Lock 265 feet long, 40 feet wide, with a lift of 15.3 feet:	
Lock walls, 6,415 cubic yards concrete; lift and miter walls, 166 cubic yards concrete; lock floor, 2 feet thick, 746 cubic yards concrete; total, 7,327 cubic yards, at $6	$43,962
Excavation—	
Earth, 2,400 cubic yards, at 30 cents	720
Rock, 800 cubic yards, at $1.25	1,000
Paving slope, 1,200 cubic yards, at $1.25	1,500
Cofferdam, 445 linear feet, at $6	2,670
Timber and pile foundation for lower end of lock, 480 piles driven and capped, at $4	1,920
Two pairs wooden gates, with valves for filling lock, gate anchorages, and machinery for operating gates	3,500
	55,272
Dam and abutment:	
Excavation, earth, 1,250 cubic yards, at 30 cents	375
Timber, 107,000 feet, B. M., at $12	1,284
Rock filling and riprap, 2,000 cubic yards, at $1.25	2,500
Drift bolts, 4,000 pounds, at 5 cents	200
Spikes, 6 kegs, at $10	60
	4,419
Land and residence for lock keeper	2,000
Excavating a channel through rock bar near Martins Landing, 60 feet wide and 4 feet deep at low water, 700 cubic yards rock, at $1.25	875

SUMMARY.

Lock	55,272
Dam	4,419
Land and residence for lock keeper	2,000
Channel near Martins Landing	875
	62,566
Engineering and contingencies	6,434
Total	69,000

It will be observed in the estimate that it is proposed to make the floor of the lock and the lift and miter walls of concrete. It may be

SITE OF PROPOSED LOCK

ON

YAMHILL RIVER, OREGON.

Surveyed under direction of

MAJOR JAMES C. POST, CORPS OF ENGINEERS, U.S.A.

By R.A. Habersham

Asst. Engr.

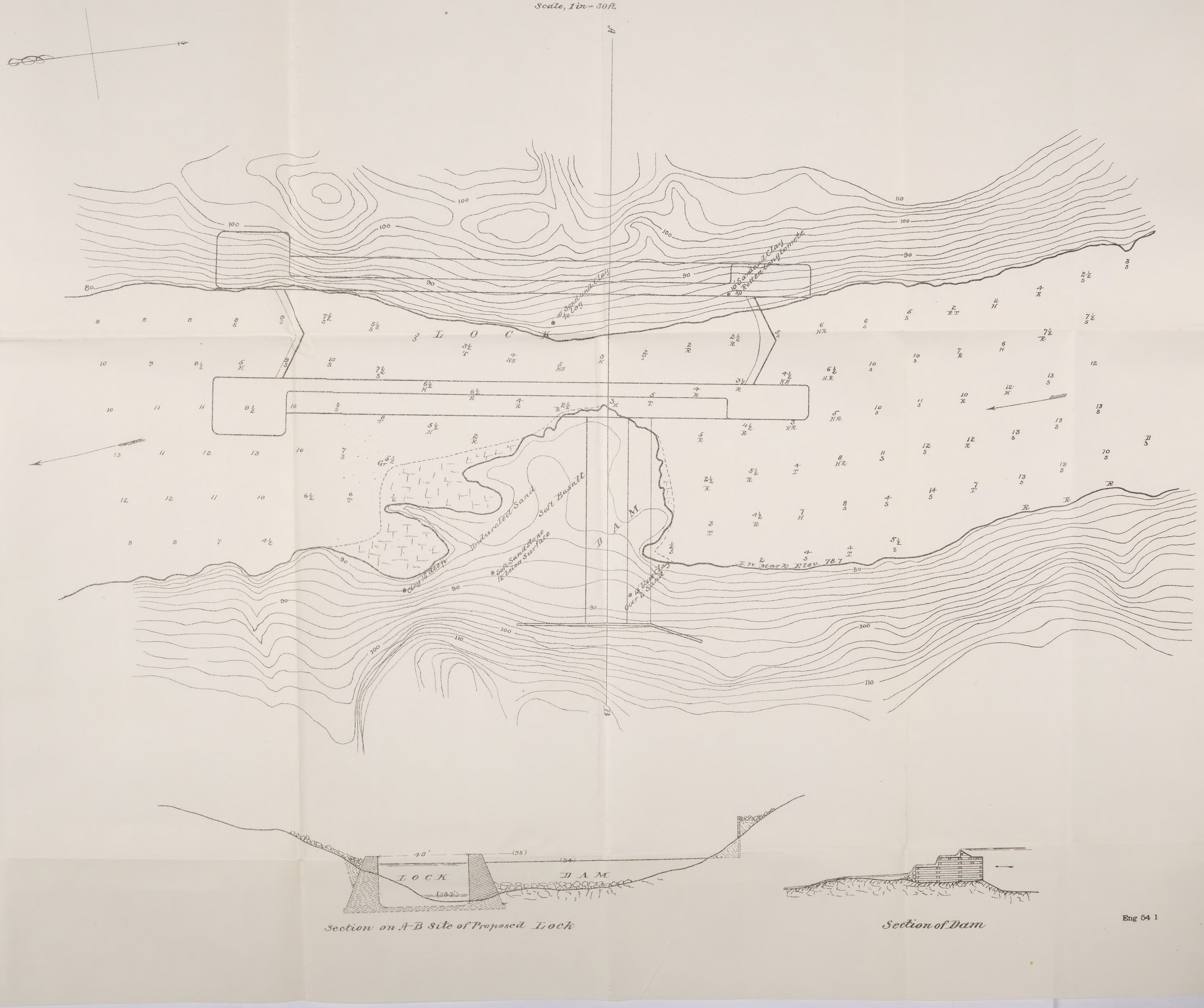
SEPT, 1894.

Scale, 1 in = 30 ft.

U.S Engineer Office, Portland Oregon
March 6, 1895

Sent to the Chief of Engineers U.S.A. with letter of this date.

Major Corps of Engineers U.S.A.



Section on A-B Site of Proposed Lock

Section of Dam

Eng 54 1

found more economical in constructing such a small lock to make these parts of wood, and this material may serve as well, but the estimate is based on concrete to provide for contingencies that may arise when the pit for the lock is excavated.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers, U. S. A.

Brig. Gen. THOMAS L. CASEY,
Chief of Engineers, U. S. A.
(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., March 13, 1895.

Respectfully forwarded to the Chief of Engineers, recommended.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.

U U 14.

SURVEY OF COLUMBIA RIVER BELOW TONGUE POINT, BY WAY OF THE SOUTHERN CHANNEL IN FRONT OF ASTORIA, OREGON.

UNITED STATES ENGINEER OFFICE,
Portland, Oreg., May 25, 1895.

GENERAL: In compliance with instructions contained in Department letter of September 25, 1894, * * * I beg to submit the following report upon the survey of the "Columbia River below Tongue Point, by way of the southern channel in front of Astoria," provided for in river and harbor act of August 17, 1894.

The survey designated by the act was understood to include all that portion of the Columbia River known as the southern channel, and which begins nearly opposite Tongue Point and extends along the front of Astoria to Smiths Point, a distance of 5½ miles. This channel forms the only navigable connection for vessels of deep draft between the Columbia River above Tongue Point and the sea. It appears on the chart of Vancouver, dated 1792, and is believed to have existed continuously since, as it is shown on all charts made from subsequent surveys, although the latter indicate that the channel has varied somewhat from time to time in location, width, and depth. During the last few years the movement of the sands has been developing a short turn in the channel about a mile below Tongue Point, causing considerable difficulty to navigation. This difficulty has lately become so great that Congress was asked to provide for a survey of the channel with a view of improving it and increasing its capacity for the accommodation of the large-sized vessels now engaged in the commerce of the Columbia River.

The field work of the survey was commenced in October, 1894, and was completed in the following month, and the results obtained are shown on the inclosed map. Several lines of soundings, extending from the south channel across the river to the Washington shore, have also been plotted for a better understanding of the subject.

By reference to the map it will be observed that the southern channel begins at the deep pocket in the vicinity of Tongue Point, and, following a southwesterly course, passes in front of the wharves of Astoria. After leaving the deep pocket the channel is narrow and fairly straight for the first mile, and nowhere less than 23 feet in depth at the average of the lowest low water. At the termination of this distance there is a sudden deflection to the right and then to the left to pass around the rocky reef upon which the ship *Sylvia de Grasse* was wrecked in 1849. At this locality the shoalest water in the entire channel, 19 feet referred to the same plane, is encountered. Beyond this point the width and depth gradually increase, and the direction is nearly straight throughout the remainder of the distance surveyed.

A careful comparison with the latest chart of this channel—that of the Coast and Geodetic Survey of 1889—shows that material changes have taken place since that date. The head of the shoal separating the upper end of the channel from the deep pocket has moved in a southwesterly direction 1,000 feet, and at the same time has become narrower by the wearing away of its northern side. The southern channel throughout the first mile is nearly the same in position and in width as it was in 1889, though it is at present somewhat deeper. At the end of this mile, or near the Sylvia de Grasse Reef, the channel, while nearly the same in position as formerly, has become contracted by the extension of the shoal on its north side to nearly one-half its former width, it being now only 200 feet wide between the 18-foot contours. The depth has also diminished from 1 to 1½ feet, and I am informed that at the present time it is only possible for the long deep-draft vessels frequenting the port of Portland to make this turn at high water, and even then only at great risk of going ashore or of striking the wharves opposite this locality. Below the Sylvia Reef the channel has changed but little in position, but its width between the 18-foot contours has diminished from 50 to 250 feet, the depth remaining practically the same. Considered as a whole, the channel has therefore deteriorated considerably since 1889.

To the north of the south channel there is shown on all charts of this portion of the river what is known as the middle channel. The deep pocket at Tongue Point forms the upper portion of this channel, and from this it follows a westerly direction and joins the deep water opposite Fort Stevens, north of what is called Desdemona Sands. It has never been available for commerce, owing to the shifting character of its lower or western portion, caused by the heavy ocean swells which cross the bar at the mouth of the river and break upon the shoals at its junction with the deep water. The latest survey of this channel was made by this office in 1891, and its location, width, and depth as then determined has been compared with the results of the recent survey to ascertain what changes, if any, have taken place, and to account, if possible, for the deterioration of the south channel. This comparison shows that the pocket at the upper end of the channel has increased in width about 1,000 feet by the erosion of the shoal separating it from the south channel. The length of the pocket, indicated by the position of the 18-foot and 30-foot contours, is practically unchanged, but the 24-foot contour has moved westward 10,000 feet. The lower end of the channel and the bar caused by the action of the waves, upon which there is but 15 feet at the mean of the lowest low waters, remains about the same. It is evident from the condition of this channel that the large volume of water voided by it during ebb tide becomes distributed over the shoals and passes into the deep water opposite Fort Stevens

through the several small channels indicated on the map of the survey. The only one of these latter channels worthy of special mention is one that seems to have been formed since the survey of 1891, and which crosses the shoal between the middle channel and the south channel in a southwesterly direction and joins the south channel about half a mile below the Sylvia de Grasse Ledge.

At the present time it is doubtful if this channel has exerted much influence in causing the changes that are shown to have taken place in the upper portion of the south channel, but should it continue to deepen and a larger portion of the tidal flow pass through it, so that it becomes a navigable channel, there is no doubt that it will seriously affect the navigability of the present south channel, and it may cause shoals to form in front of about one-half the water front of Astoria.

To ascertain the direction of the tidal currents between Tongue Point and Smiths Point, several double floats were placed in the channel off Tongue Point at intervals across the head of the pocket about two hours after high water, and similar floats were placed in the channel opposite Smiths Point about two hours after low water. The direction and mean velocity of each of these floats are indicated on the survey map. It will be observed from these that on the ebb tide an eddy seems to be formed below Tongue Point, as the float nearest shore, after proceeding downstream some distance, returned. This eddy was observed to continue till very nearly the last of the ebb tide. The next two floats in their order from shore moved in a southwesterly direction and crossed near the upper end of the shoal, separating the middle channel from the south channel, and afterwards continued in the latter. The remainder of the floats followed nearly the direction of the middle channel. Upon the flood tide the floats indicated a strong tendency of the flood currents coming up the south channel to spread over the shoals to the north of it, none of the floats passing entirely through the present south channel.

The present project for improvement of the Columbia and Willamette rivers between Portland and the sea contemplates securing a low-water depth of 25 feet throughout this distance. The south channel in front of Astoria is a necessary part of this deep channel, and its improvement was proposed when the project was submitted in 1891. Apparently at that time there was but little work considered necessary in order to obtain the required depth in this channel, as only a small item for dredging at this locality is included in the estimate. The deterioration of the channel developed by the present survey render additional work necessary at the present time, and it is proposed in making the improvement to open a waterway in front of Astoria 25 feet deep and 250 feet wide at the bottom in accordance with the general project for the river. This will include opening a more direct channel of these dimensions from Tongue Point to below the wreck of the Sylvia de Grasse by dredging and the removal of the outer portion of the Sylvia de Grasse Ledge. The proposed new channel is located upon the map of the survey.

It will be observed by referring to this map that some of the floats on both the flood and ebb tides crossed the head of the shoal, separating the middle and south channels, and followed nearly the general direction proposed for the new channel. In view of this fact it is believed that the tidal currents will maintain the new channel after it is once thoroughly opened, and the portion of the Sylvia de Grasse Ledge, now obstructing the channel, is removed.

The following is an estimate of the cost of the improvement proposed:

ESTIMATE.

Dredging channel 250 feet wide, 355,000 cubic yards sand, at 10 cents	$35,500
Removing portion of Sylvia de Grasse Ledge, 12,500 cubic yards rock, at $6	75,000
	110,500
Engineering and contingencies, 10 per cent	11,050
Total	121,550

The following maps are herewith inclosed:

Map of survey of 1894.

Map showing comparison of contours of surveys of 1889 and 1891 with those of 1894.

Very respectfully, your obedient servant,

JAS. C. POST,
Major, Corps of Engineers.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

(Through Col. G. H. Mendell, Corps of Engineers, Division Engineer, Pacific Division.)

[First indorsement.]

U. S. ENGINEER OFFICE,
San Francisco, Cal., June 1, 1895.

Respectfully forwarded to the Chief of Engineers.

The importance of this channel and the necessity of increasing its capacity by enlarging the circulation of tides are clearly shown in this report.

The measures proposed for the improvement are recommended.

This channel is the thoroughfare for large local and foreign commerce, and its importance makes the improvement worthy to be done by the Government.

G. H. MENDELL,
Colonel, Corps of Engineers, Division Engineer.



APPENDIX V V.

SUPERVISION OF THE HARBOR OF NEW YORK.

REPORT OF LIEUT. COMMANDER DANIEL DELEHANTY, UNITED STATES NAVY, SUPERVISOR OF THE HARBOR OF NEW YORK, FOR THE FISCAL YEAR ENDING JUNE 30, 1895.

OFFICE OF THE SUPERVISOR
OF THE HARBOR OF NEW YORK,
New York, July 9, 1895.

GENERAL: I have the honor to submit herewith a report of the duties and operations of this office for the fiscal year ending June 30, 1895; also an estimate of the amount required for the fiscal year ending June 30, 1897.

The chief obstacle in the way of a complete and necessary change in the methods of protecting this harbor against the deposit of obstructive and injurious material is the present unqualifiedly bad system for the final disposition of the city refuse. So long as it is continued it is impossible to effect the reforms this office has in view of recommending pertaining to the disposition of the enormous amount of so-called waste material that is annually transported over these waters and deposited at the mouth of the harbor to the injury of the channels.

Authority is vested in this office to prescribe the limits within which it shall be unlawful to deposit this material. The limit might be fixed at such a distance seaward from the mouth of the harbor as to amply protect the channels, but the character and type of boats used are such as to preclude their venturing sufficiently far from the coast under all conditions of weather.

The solution of the difficulty lies in the utilization of this material for filling-in purposes. There are large areas of partially submerged lands, conveniently located, that might be economically reclaimed with it and to the protection of the harbor and the advantage of this community. I am clearly of the opinion that to accomplish this, with little or practically no opposition, it is only necessary for the city authorities to take the initiative in the disposition of the city's refuse.

This office has persistently labored to this end, and in July last the mayor conceded the importance of its representations and took prompt action in the matter by appointing an advisory commission to examine into and report on the subject.

With the approval of the Honorable Secretary of War I accepted the invitation extended in the following letter:

CITY OF NEW YORK, *Office of the Mayor, July 26, 1894.*

Hon. FRANKLIN EDSON, THOMAS L. JAMES, *Lieutenant-Commander, U. S. Navy*, DANIEL DELEHANTY, CHARLES G. WILSON, *President of Board of Health*, and Commissioner WILLIAM S. ANDREWS.

GENTLEMEN: I have to ask your cooperation as citizens and officials in the important work of examining, as an advisory commission, into the subject of the final disposition of the refuse of this city. The disposition of the street-cleaning refuse, the ashes and garbage of so large a community, presents one of the most difficult problems of city government. The present system is uncertain and expensive, in addition to being far from satisfactory in its results as affecting the health and comfort of the people. Even when the greatest efficiency has been reached in this service there continued to be complaints of the accompanying nuisance and danger to some parts of our city, or its vicinity, or to our commercial interests.

It is, in my opinion, within the reach of science to remedy these evils in these days of progress and improvement in every direction. There must be the possibility of devising a way to collect and remove the waste material of the city without nuisance or danger to health or menace to commerce; a way to consume or dispose of it, even if there may not be a way to utilize some or all of it.

If your investigation should result in a recommendation in favor of cremating our street refuse, the best and most effective system should be the one adopted. A careful examination of each will be necessary to determine what system, if any, should be recommended for the exceptional conditions of this great and growing population.

No greater public service can be done than would result from your successful consideration of this question. A report upon the facts and such suggestions as the inquiry develops would of itself be of great value to the city. I shall direct that the various city departments extend to your commission every possible facility for your work. The mayor's office is at your disposal for a meeting of organization and conference at any time you may agree upon and designate.

Very truly yours,

THOS. F. GILROY, *Mayor.*

The commission organized in the mayor's office August 1, 1894. The subsequent meetings were held in the office of the supervisor of the harbor, the investigations extending over a period of nearly four months.

After the first meeting of the commission the public was notified through the daily press that all schemes for the final disposition of the city's refuse would be received and carefully examined. In response to this notification seventy different schemes were submitted, in most cases accompanied with complete drawings of proposed plants or of those in actual operation. Twenty-one of these were rejected as impracticable, and the projectors of the remaining forty-nine were invited to appear before the commission at specified dates to explain in detail the merits and workings of their respective systems.

It was an evidence of the widespread interest in the subject that forty-five different parties, from all sections of the country and from foreign countries, representing as many different schemes, appeared before the commission and were accorded hearings. From this source much valuable information was obtained, which was supplemented by voluminous and exhaustive reports furnished by Lieut. Commander W. S. Cowles, the naval attaché of the United States embassy at the Court of St. James, on the methods employed in the various vestries of London and Liverpool. In addition, applications were made by the commission to the local boards of health and to the mayors of all the cities in the United States where modern methods were known to be employed in disposing of the refuse for information concerning the merits, defects, and cost of the systems in use, and this was in most cases satisfactorily furnished. A member of the commission, the Honorable Thomas L. James, made a personal inspection of the plants in

operation in Liverpool, Manchester, Bristol, and the Chelsea Parish of London, Great Britain.

A vast amount of information was acquired from these sources, which was materially added to by the commission personally inspecting the plants in operation, the conditions under which they were operated, and results in Boston, Montreal, Chicago, St. Louis, Atlanta, Cincinnati, Allegheny, Philadelphia, Wilmington, Del., Yonkers, Coney Island, and Carnarsie, Long Island.

The most important conclusion of the commission, so far as the interests of this harbor are concerned, was its emphatic disapproval of depositing the refuse at sea, which it pronounced "reprehensible from every point of view." It also condemned as "unqualifiedly bad" the present system of loading the refuse boats, which is responsible in a large degree for the serious defilement and injury to these waters.

The numerous recommendations of the commission, if adopted, will prove of great benefit to the harbor, and as the public interest in the matter is widespread there is every promise of an early inauguration of these much-needed reforms.

In addition to the city refuse, permits are issued during the year for the deposit off the entrance to the harbor of about 5,000,000 cubic yards of dredged material from city improvements.

It requires unceasing vigilance on the part of the entire force of this office to insure the deposit of this material at the designated point where it can work the least injury to the channels.

As a rule, the employees of those engaged in this business resort to every subterfuge to evade the law, and there are good reasons for believing that the employers not infrequently encourage the commission of these illegal practices.

It was a custom for the tows to take advantage of thick weather, deposit their loads in the harbor, and return the permit to this office with the indorsement "not used," or with the explanation that they had failed to meet the patrol boat. Abundant reasons existed for believing that scows frequently discharged part of their loads within the harbor and proceeded with the remainder to the proper point of deposit in order to render towing easier.

Another evil which required serious attention was the practice of towing back into the harbor loaded or partially loaded scows which, owing to defective machinery or refractory material, could not be promptly dumped at the dumping point, but which was subsequently deposited inside the harbor. These unlawful acts were so common that the results were a serious menace to the harbor and a wholly indefensible expense to the Government annually for dredging.

To check these evils and enforce a compliance with the law it was essential to devise a system by which this office should know absolutely each day the number or names of all dumpers and scows loaded within the harbor, and to keep track of them until they had unloaded at the points designated on their respective permits.

As a large proportion of the dredging is being done by the Government, under Lieut. Col. G. L. Gillespie, of the Engineer Corps, U. S. Army, an arrangement was entered into with this officer in which he agreed to disapprove the claims for payment for such dredging where the material was shown by this office not to have been deposited at the points designated on the permits. To secure the necessary evidence blank forms were furnished by this office to Colonel Gillespie's inspectors on the various dredges, which they are required to fill in at the close of each day's work, specifying the number or name of every

dumper "fully loaded" or "partially loaded," mailing the report immediately to this office.

On the applications for permit to deposit this material, made by the contractors, the numbers of the dumpers are required to tally with those reported by the inspectors, and these numbers are again checked in the lower bay, in the vicinity of the mud buoy, by the deputy inspectors on board the patrol boats of this office with the numbers of the dumpers composing the tows.

By these means a continuous record is kept of every dumper from the time of receiving its full or partial load to the time of deposit at buoy. Discrepancies are revealed at a glance over the record book kept in this office. The checkage of payments has had a salutary effect on the contractors, and no difficulty is experienced in holding the Government inspectors up to a strict performance of their duty.

The transportation of New York City refuse has been a fruitful source of trouble and complaint. A large part of it is carried on deck scows to the place of deposit, which is now outside of Sandy Hook light-ship.

These scows are unloaded by manual labor. They are uncomfortable and unsafe in a sea way, and as it requires three hours to discharge a fully loaded scow, the crews, in order to shorten their stay outside, took advantage of every opportunity to unload en route, to the serious defilement of the harbor and beaches.

There was much difficulty experienced in breaking up this practice. Finally an arrangement was made between this office and the commissioner of the department of street cleaning, by which the commissioner was to enforce the rule that all the implements for unloading should be kept under lock and key until the proper time for delivery, and to refuse to pay the contractor for unloading any scow which had been discharged wholly or in part within the limits of the designated point of deposit. In addition the deputy inspectors on the patrol boats of this office were instructed to summarily arrest the captain of any scow on which the law was violated in their presence.

In foggy or thick weather it was almost an invariable practice for these scows and the city dumpers to dump short without danger of detection, but I believe there is now no possibility of this being done henceforth, as the commissioner of the street cleaning department, on my recommendation, has given me his assurance that no payment will be made for towage in cases where the towboats fail to report with their tows to the captain of the light-ship; and as the captain of the light-ship makes daily report to this office the check is complete.

The strict enforcement of these rules is manifest in the noticeable improvement in the condition of the harbor, especially in the lower bay.

The remainder of the material requiring close supervision consists of dredgings under private contract and débris from city improvements, technically known as cellar dirt. This duty devolves on the two steam launches *Active* and *Alert* and the naphtha launch. The two first-mentioned boats cover the North and East rivers, western end of Long Island Sound, and upper bay, while the naphtha launch patrols the Kills, Princes and Newark bays, and tributary waters. These boats are useful in many ways in detecting and preventing violations of the law. They are employed usually in daytime, and at night when deemed advisable. It would be of great advantage if they were somewhat larger, so that their crews might be increased and quartered on board and the boats used continuously to watch the cellar dirt and dumpers employed in other than Government work.

The cellar dirt has been a constant source of trouble. As it contained more or less floatable refuse its deposit at the mud buoy worked to the injury of the harbor, and the necessity of depositing it farther seaward was manifest. As such action necessarily entailed increased expense on the contractors, I endeavored to avoid taking it. After a careful investigation of the subject a satisfactory arrangement was entered into with the contractors, in which they agreed to separate the floatable refuse from the cellar dirt and dispose of it properly, accompanying each application for a permit with a certificate that the dumpers were free from floatable refuse. For a time this worked with good results, but through carelessness, or possibly on account of the cost and trouble of separation, the agreement in most cases was practically disregarded, resulting in a foul condition of the harbor and frequent complaints of the nuisance to this office. To correct the evil the regulations governing the deposit of city refuse were applied to the cellar dirt, the point of deposit being southeast of Sandy Hook Light-ship. In order to enforce this regulation it will be necessary to have an additional patrol tug on duty at night, and this will be done in a few days, as soon as the *Argus*, which is now under repairs, is available.

Among the important cases of illegal dumping prosecuted by the United States district attorney for the southern district of New York was that of John Ansbro, the captain of the tug *P. H. Wise.* He was indicted on October 9, 1894, for violations of the act of June 29, 1888, passed to prevent illegal dumping in the harbor of New York and in the adjacent waters. The indictment set out three offenses. The case was tried before Judge Benedict and a jury in the circuit court in this district on October 24 and 25, and the defendant was convicted on the second count of the indictment of having unlawfully dumped mud at a place other than that designated in the permit issued to him by the supervisor. After a motion in arrest of judgment had been argued and denied, the defendant was sentenced on December 20, 1894, to six months imprisonment. He gave bail and appealed to the Supreme Court of the United States. The case is now on the docket of the Supreme Court, and has been advanced for a hearing at the next term of the court.

On the 20th of August last, while the steam launch *Alert* was on duty in the North River, the ferryboat *Fanwood*, belonging to the New Jersey Central Railroad, ran into and sank her off Pier 13. Under agreement with the underwriters of the *Fanwood* I immediately made arrangements for raising the boat, the liability for cost and damages to be determined by the courts.

The district attorney for the southern district of New York, under instructions from the Solicitor of the Treasury, filed a libel in admiralty against the *Fanwood* on September 8, 1894. The case was tried in the district court before Judge Brown on March 13, 1895. On March 22 the judge rendered his decision, dividing the damages, and an order was made referring it to Commissioner Lyman to take proof of the damages. I submitted a statement showing the expenses incurred in raising and repairing the *Alert.* The proctors for the owners of the *Fanwood* offered to pay $600 in settlement, and on the recommendation of the district attorney the Solicitor of the Treasury recommended the acceptance of the offer to the Secretary of the Treasury.

The owners of the *Fanwood* have deposited the money in the subtreasury, and have sent their petition to compromise the case to the Secretary.

By act of Congress approved August 18, 1894, $45,000 was appropriated for the purchase or construction of a steam tug for this office. After duly advertising for proposals for construction of same the con-

tract was awarded on November 2, 1894, to John H. Dialogue & Son, of Camden, N. J. This boat was launched March 11 and named *Daniel S. Lamont*, was delivered to this office on April 27, 1895, and immediately assigned to patrol duty.

By act of Congress approved March 2, 1895, $45,000 was appropriated for the purchase or construction of a steam tug for this office, the appropriation to be immediately available. In view of the fact that no appropriation was made for the maintenance of this vessel I deemed it advisable to delay the construction in order that the boat should not be completed until after Congress again assembles.

The plans and specifications for this boat are about completed, and proposals will be duly advertised for during the present month.

With this increased force to guard the harbor I feel confident its protection against illicit dumping will be assured.

There has been moved and deposited into the waters outside the harbor, at properly designated places and behind bulkheads in the neighborhood of New York, during the fiscal year ending June 30, 1895, the amount of 8,952,453 cubic yards of material—mud, city refuse, garbage, cellar dirt, ashes, acids, lime, and other material—as per the following recapitulation:

Place of deposit.	Kind of material.	Amount.
		Cubic yds.
Mud buoy	Mud, etc.	4,864,210
Scotland Light-ship	do	336,097
Sandy Hook Light-ship	City refuse, etc.	2,577,230
Long Island Sound	Mud, etc.	399,110
North River	Dirt, ashes, etc., behind bulkheads and on shore for filling.	169,005
East River	do	59,347
Harlem River	do	256,898
New York Bay	do	39,810
Passaic River	do	56,312
Newark Bay	do	1,800
Staten Island Sound	do	98,467
Shrewsbury River	do	3,875
South River, New Jersey	do	15,147
Hackensack River	do	13,140
Arthur Kills	do	7,738
Shoal Harbor, New Jersey	do	8,150
Barren Island	Dead animals, etc., on shore in store	46,117
Total		8,952,453

Permits issued, 10,050.

From the foregoing statement it will be seen that 8,176,647 cubic yards of mud, city refuse, etc., was deposited near the mouth of the harbor, and 775,806 cubic yards of cellar dirt, ashes, and other inoffensive material was used for filling in behind bulkheads, reclaiming lands, etc., for which special permits were issued.

The following is a statement of the appropriation made for "prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City," 1895:

For pay of inspectors, deputy inspectors, office force, and expenses of office		$15,000.00	
Expended to July 1, 1895	$14,117.01		
Outstanding liabilities	504.66		
		14,621.67	
			$378.33
For pay of crew and maintenance of steamer *Argus*		8,000.00	
Expended to July 1, 1895	6,230.18		
Outstanding liabilities	1,768.12		
		7,998.30	
			1.70

For pay of crew and maintenance of steamer *Nimrod*		$8,000.00	
Expended to July 1, 1895	$7,720.78		
Outstanding liabilities	265.40		
		7,986.18	
			$13.82
For purchase or construction of one steam tug		45,000.00	
Expended to July 1, 1895		40,114.42	
			4,885.58
Balance			5,279.43

The following is an estimate of appropriations required for service of the fiscal year ending June 30, 1897, by the supervisor of the harbor of New York:

Detailed objects of expenditure and explanations.	Estimated amount that will be required for each object.	Amount appropriated for fiscal year ending June 30, 1896.
Prevention of obstructive and injurious deposits within the harbor and adjacent waters of New York City:		
For pay of inspectors, deputy inspectors, office force and expenses of office, and maintenance of launches Active, Alert, and Lookout	$18,000	$15,000
For pay of crew and maintenance of steamer Nimrod	10,000	10,000
For pay of crew and maintenance of steamer Argus	10,000	8,000
For pay of crew and maintenance of steamer Daniel S. Lamont	12,000	12,000
For pay of crew and maintenance of one steam tug under construction	12,000	.....
For the purchase or construction of one steam tug	.....	45,000
Total	62,000	90,000

Very respectfully, your obedient servant,

DANIEL DELEHANTY,
Lieut. Comdr., U. S. Navy, Supervisor.

Brig. Gen. WM. P. CRAIGHILL,
Chief of Engineers, U. S. A.

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